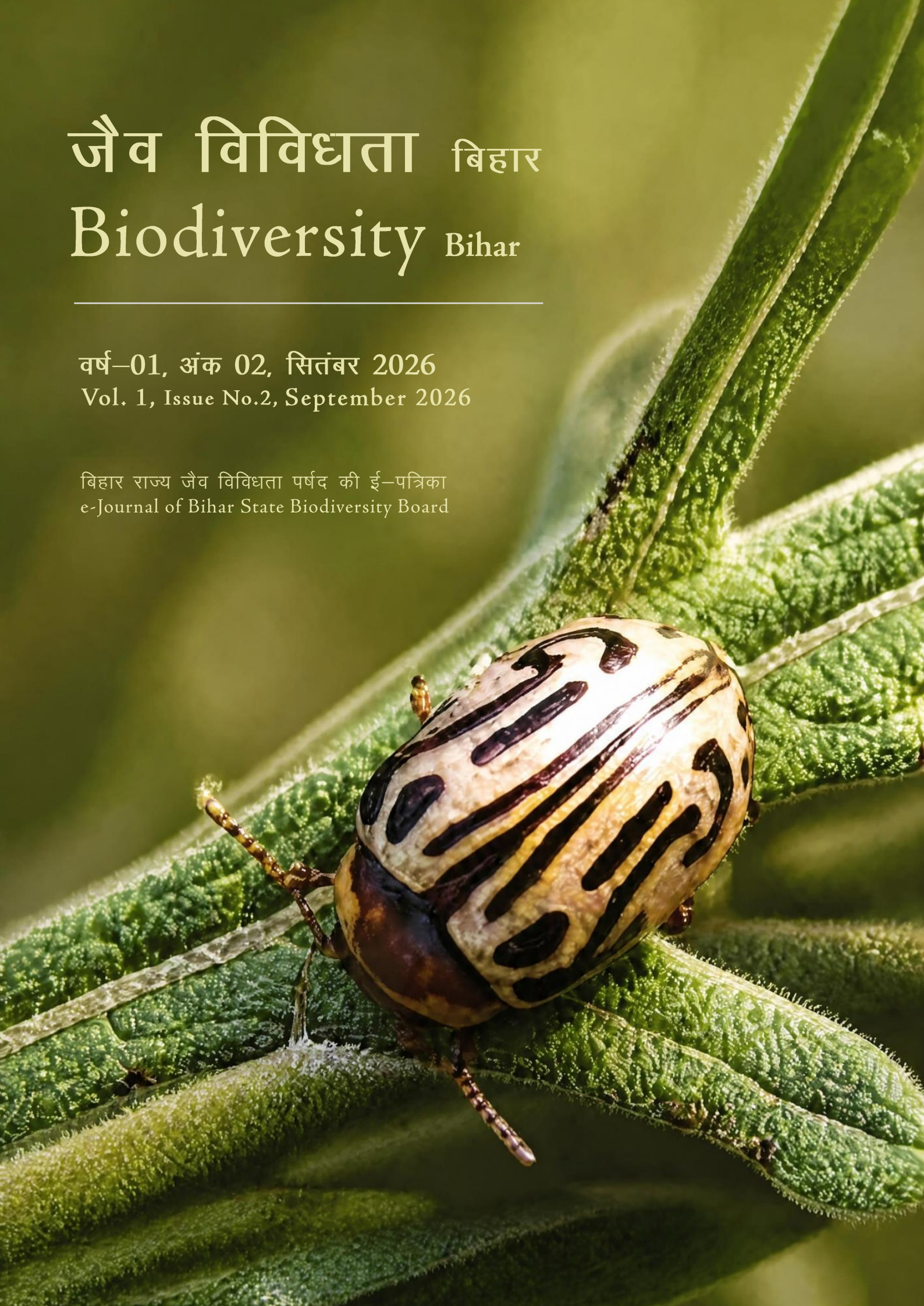
जैव विविधता बिहार
Biodiversity Bihar

वर्ष–01, अंक 02, सितंबर 2026
Vol. 1, Issue No.2, September 2026

बिहार राज्य जैव विविधता पर्षद की ई–पत्रिका
e-Journal of Bihar State Biodiversity Board



Biodiversity Bihar

Vol. 01 | Issue 02 | September 2026

Issue Date : 8 October 2026

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Cover Photo	*Zygogramma bicolorata* (Mexican/Parthenium beetle), a leaf beetle introduced from Mexico to India as a biological control agent against the invasive weed *Parthenium hysterophorus*. First released in India in 1984, it remains an important example of biological control of invasive species. **©Sunanda Kumari**
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जैवविविधता बिहार

वर्ष– 01 | अंक 02 | सितंबर 2026

प्रकाशन तिथि : 8 अक्टूबर 2026

संपादक मंडल

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साक्षी, अमरेश कु. शर्मा, निशांत राज एवं मिहिर कु. झा

आवरण चित्र

Zygogramma bicolorata (मैक्सिकन / पार्थेनियम बीटल) एक पर्णभक्षी भृंग है, जिसे आक्रामक खरपतवार *Parthenium hysterophorus* के जैविक नियंत्रक के लिए मैक्सिको से भारत लाया गया था। भारत में इसे पहली बार 1984 में छोड़ा गया था और यह आक्रामक प्रजातियों के जैविक नियंत्रण का एक उदाहरण है।

© सुनंदा कुमारी

अस्वीकरण

'जैव विविधता बिहार' पत्रिका में प्रकाशित लेखों में व्यक्त विचार एवं दृष्टिकोण संबंधित लेखकों के हैं, जिनसे बिहार राज्य जैव विविधता पर्षद् का सहमत होना अनिवार्य नहीं है। पत्रिका में प्रकाशित किसी भी आलेख के पुनर्प्रकाशन से पूर्व बिहार राज्य जैव विविधता पर्षद् की अनुमति आवश्यक है।

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आमुख

बिहार जैव विविधता पर्षद् की ओर अभिवादन!

हमारी पत्रिका के दूसरे अंक में अगस्त–सितम्बर 2026 की मुख्य गतिविधियों और कार्यक्रमों की झांकी प्रस्तुत है।

पत्रिका के प्रारम्भिक चरण में हमने सम्पादक मंडल का गठन कर लिया है, जिसमें कुछेक विशेषज्ञ जुड़ गये हैं।

इस अंक में सम्मिलित लेखों की विविधता बढ़ी है तथा इसमें खास विषयों पर ज्ञानवर्धक जानकारी के साथ–साथ समीक्षा एवं शोध कार्यों के आलेखों को भी सम्मिलित किया गया है।

अपेक्षा है कि यह अंक रूचिकर होगा। पत्रिका की रूप–रेखा और इसकी सामग्री के बारे में आपके सुझावों का स्वागत है।

अमित कुमार

सचिव, बिहार राज्य जैव विविधता पर्षद्

Foreword

Greetings on behalf of Bihar State Biodiversity Board!

The second edition of our journal presents a glimpse of the key activities and programmes from **August–September 2026**.

In this initial phase of the journal, we have formed an editorial board, joined by expert members.

The variety of the articles included in this issue has grown. Alongside enriching information on special topics, it also features review and research papers. We hope you will find this edition engaging.

Your valuable feedback and suggestions regarding the design and content of the magazine are most welcome.

Amit Kumar

Secretary, Bihar State Biodiversity Board



Grey-headed Swamphen *Porphyrio poliocephalus*

Events and Activities
कार्यक्रम एवं गतिविधियाँ

1. भागलपुर जिले के घटोरा आर्द्रभूमि को जैव विविधता विरासत स्थल घोषित किये जाने हेतु स्थानीय जैव विविधता प्रबन्धन समितियों से परामर्श (01–04 अगस्त, 2026)

घटोरा आर्द्रभूमि जैव विविधता महत्व का एक विशिष्ट स्थल है। इसे जैव विविधत विरासत स्थल घोषित करने हेतु निकटस्थ पांच पंचायतों की जैव विविधता प्रबन्धन समितियों का परामर्श किये जाने हेतु पर्षद् के जी.आई.एस. पदाधिकारी डॉ. जय कुमार द्वारा 01 से 04 अगस्त की अवधि में स्थानीय लोगों के साथ बैठक आहूत की गयी इसमें जैव विविधता के महत्व, लोक जैव विविधता पंजी के संधारन एवं अद्यतीकरण पर विस्तृत चर्चा की गयी।

घटोरा आर्द्रभूमि के चयनित भाग को जैव विविधता विरासत स्थल घोषित करने हेतु प्रबंधन समितियों द्वारा विधिवत अनुशंसा दी गयी।



घटोरा आर्द्र भूमि को जैव विविधता विरासत स्थल बनाने की कवायद तेज

खबरों की तह तक/श्याम ठाकुर

बिहपुर, भागलपुर। प्रखंड की महत्वपूर्ण घटोरा आर्द्र भूमि (वेटलैंड) को जैव विविधता विरासत स्थल के रूप में विकसित करने की दिशा में गुरुवार को जगतपुर पंचायत में जैव विविधता प्रबंधन समिति की बैठक हुई। बैठक की अध्यक्षता मुखिया अरुणा देवी ने की। बैठक में बिहार राज्य जैव विविधता परिषद के क्षेत्रीय स्टेशन के जीआईएस एवं रिमोट सेंसिंग पदाधिकारी डॉ. जय कुमार ने कहा कि घटोरा आर्द्र भूमि स्थानीय जैव विविधता का महत्वपूर्ण केंद्र है। यहां विभिन्न प्रकार के जलीय जीव, पक्षी और वनस्पतियां पाई जाती हैं, जिनका संरक्षण पर्यावरणीय संतुलन के लिए आवश्यक है। उन्होंने बताया कि जैव विविधता विरासत स्थल का दर्जा मिलने से इस क्षेत्र के संरक्षण को संस्थागत मजबूती मिलेगी। इसके लिए पीपुल्स बायोडायवर्सिटी रजिस्टर (पीबीआर) को अद्यतन करने, स्थानीय जैव संसाधनों का दस्तावेजीकरण करने तथा जनभागीदारी बढ़ाने पर जोर दिया गया। बिहपुर राम जानकी ठाकुरबाड़ी के महंत नवल किशोर दास ने पर्यावरण संरक्षण को सामाजिक दायित्व बताते हुए जल स्रोतों, आर्द्र भूमि और स्थानीय वनस्पतियों के संरक्षण में जनसहभागिता बढ़ाने की अपील की। बैठक में जैव विविधत प्रबंधन समिति ने व्यापक जनजागरूकता अभियान चलाने, पौधरोपण को बढ़ावा देने और प्राकृतिक संसाधनों के संरक्षण का संकल्प लिया। बैठक में वनपाल विजय कुमार सिंह, वनरक्षी शिवम कुमार, समिति के सदस्य, पंचायत प्रतिनिधि एवं अन्य ग्रामीण मौजूद थे।

2. कांवर ताल (बेगूसराय जिला) क्षेत्र से संबंधित पंचायतों में जैव विविधता प्रबन्धन समितियों के साथ बैठक आहूत कर लोक जैव विविधता पंजी (PBR) के अद्यतीकरण का कार्य (09–10 अगस्त, 2026)



कांवर झील के संरक्षण और जैविक खेती को बढ़ावा देने पर जोर, जैव विविधता प्रबंधन समितियों की बैठक

कांवर ताल पक्षी अश्रयणी के साथ बिहार राज्य का प्रथम रामसर साईट है। इस क्षेत्र के जैव विविधता की स्थिति के आकलन हेतु क्षेत्र से सम्बद्ध 09 पंचायतों के जैव विविधता प्रबंधन समितियों के साथ विमर्श कर जन जैव विविधता पंजी (PBR) के अद्यतीकरण का कार्य विशेष अभियान के तहत प्रारम्भ किया गया। प्रथम चरण में दिनांक 09 एवं 10 अगस्त को पर्षद के जी.आई.एस. पदाधिकारी के दल द्वारा 04 पंचायतों यथा मंझौल–1, मंझौल–2, मंझौल–3 एवं राजौड़ के जैव विविधता प्रबन्धन समितियों के साथ विमर्श कर पंजी के अद्यतीकरण का कार्य किया गया।

3. पटना शहरी क्षेत्र के गंगा, पुनपुन तथा सोन नदी के अंश भाग में जैव विविधता की स्थिति पर प्रतिवेदन तैयार करने हेतु बैठक (20 अगस्त, 2026)

पटना शहरी क्षेत्र की जैव विविधता के अध्ययन के क्रम में NIT Patna, Patna University तथा College of Commerce Arts and Science द्वारा संयुक्त रूप से किये जा रहे अध्ययन के क्रम में गंगा, पुनपुन तथा सोन नदी के अंश भाग की जैव विविधता पर प्रतिवेदन तैयार करने हेतु प्रतिवेदन के स्वरूप पर विस्तृत चर्चा की गयी। अध्ययन के क्रम में संग्रहित सूचनाओं की प्रविष्टि तथा इस क्षेत्र की जैव विविधता के संरक्षण के उपयों के संदर्भ में सुझाव आदि पर विमर्श किया गया।



4. पर्षद् की 17वीं (विशेष) बैठक (25 अगस्त, 2026)

- प्रमुख निर्णय –

  (i) जैव संसाधनों तक पहुँच और लाभ साक्षाकरण व्यवस्था के तहत राष्ट्रीय जैव विविधता प्राधिकरण से पर्षद् को प्राप्त ₹ 2.05 करोड़ के व्यय के संदर्भ में विमर्श।

  (ii) राज्य में जैव विविधता विरासत स्थल अधिसूचित किये जाने हेतु 14 जिलों में चिन्हित 15 स्थलों के सदर्भ में पर्षद की अनुशंसा।



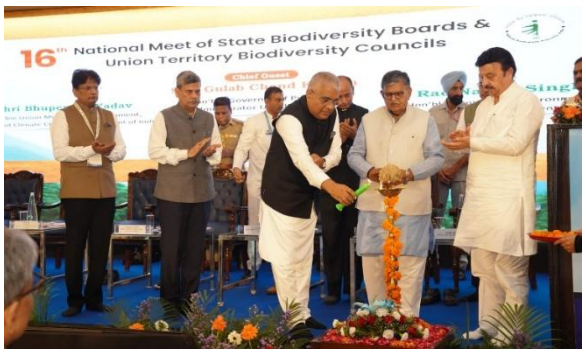
5. ललित नारायण मिथिला विश्वविद्यालय, दरभंगा परिसर स्थित नरगौना पैलेस के निकट जैव विविधता समृद्ध क्षेत्र को जैव विविधता विरासत स्थल घोषित करने एवं परिसर में अवस्थित विशिष्ट वृक्षों को जैव विविधता विरासत वृक्ष घोषित किये जाने हेतु स्थल अध्ययन एवं विश्वविद्यालय के पदाधिकारियों के साथ विमर्श (25–27 अगस्त, 2026)

ललित नारायण मिथिला विश्वविद्यालय के उप कुलपति से प्राप्त सैद्धांतिक सहमति के आलोक में विश्वविद्यालय परिसर के चिन्हित स्थल की जैव विविधता के आकलन तथा विशिष्टता के अध्ययन हेतु पर्षद् के जी.आई.एस. पदाधिकारी, डॉ. जय कुमार तथा विश्वविद्यालय द्वारा विशेष रूप से गठित कमिटि के सदस्यों द्वारा सम्मिलित रूप से अध्ययन का कार्य किया गया। परिसर में अवस्थित दो विशिष्ट वृक्ष को जैव विविधता विरासत वृक्ष घोषित करने हेतु उपयुक्त पाया गया।



निर्धारित प्रपत्र में जैव विविधता विरासत वृक्ष घोषित करने का प्रस्ताव विश्वविद्यालय प्रशासन से प्राप्त किया गया साथ ही विरासत स्थल घोषित करने हेतु स्थल क्षेत्र पर प्रतिवेदन की रूप रेखा तैयार की गयी।

6. राज्यों के जैव विविधता पर्षदों की 16वीं राष्ट्रीय सम्मेलन में बिहार राज्य जैव विविधता पर्षद् की प्रतिभागिता (6–7 सितम्बर, 2026)





राष्ट्रीय जैव विविधता प्राधिकरण द्वारा चण्डीगढ़ में आयोजित 16वीं राष्ट्रीय सम्मेलन में पर्षद की ओर से अध्यक्ष एवं उपनिदेशक द्वारा भाग लिया गया। इस राष्ट्रीय सम्मेलन के मुख्य अतिथि श्री गुलाब चन्द कटारिया महामहिम राज्यपाल, पंजाब एवं चंडीगढ़ थे जबकि श्री भुपेन्द्र यादव केन्द्रीय मंत्री, पर्यावरण, वन एवं जलवायु परिवर्तन विभाग, भारत सरकार द्वारा अध्यक्षता की गयी। सम्मेलन के तकनीकी सत्रों में संशोधित जैव विविधता अधिनियम, नियमावली एवं दिशा–निर्देशों के अनुपालन की स्थिति तथा राज्यों के जैव विविधता रणनीति एवं कार्य योजना के निर्माण की प्रगति पर विस्तृत चर्चा हुई। अन्य बिन्दुओं के साथ सभी राज्यों के प्रस्तुतिकरण एवं जैव विविधता संरक्षण हेतु किये जा रहे कार्यो को साझा किया गया।

7. जमुई जिले में जैव संसाधनों के सग्रहण एवं उपयोग से सम्बद्ध हितधारकों की कार्यशाला (11 सितम्बर, 2026)



चन्द्रगुप्त प्रबन्धन संस्थान पटना द्वारा जमुई जिले के प्रादेशिक वन क्षेत्रों प्रादेशिक वन क्षेत्रों एवं उसके आस–पास पाये जाने वाले जैव संसाधनों की उपलब्धता, संग्रहण एवं व्यवसायिक उपयोग संबंधी अध्ययन के क्रम में हितधारकों का सुझाव प्राप्त करने हेतु एक कार्यशाला जमुई वन प्रमण्डल के सभागार में आहूत किया गया। पर्षद् की ओर से उपनिदेशक श्री मिहिर कुमार झा ने भाग लेकर विषय वस्तु पर चर्चा की।

8. UGC-मदन मोहन मालवीय शिक्षक प्रशिक्षण कार्यक्रम के तहत आयोजित ऑनलाईन प्रशिक्षण कार्यक्रम में सहभागिता (12 सितम्बर, 2026)

UGC-मदन मोहन मालवीय शिक्षक प्रशिक्षण कार्यक्रम के तहत पटना विश्वविद्यालय द्वारा आयोजित Inter-disciplinary Refresher Course in Life Sciences में जैव विविधता विषय पर अध्यक्ष, बि.रा.जै.वि. पर्षद् द्वारा व्याख्यान दिया गया। 19 राज्य के विश्वविद्यालयों के 91 जीव विज्ञान संकाय सदस्यों ने इस ऑनलाईन Refresher Course में भाग लिया।



9. छः शहरी क्षेत्रों की जैव विविधता संबंधी अध्ययन कार्य के प्रगति की समीक्षा (16 सितम्बर, 2026)



BSBB Chairman Bharat Jyoti, IFS (Retd.) with CUSB Vice-Chancellor Prof. Kameshwar Nath Singh and other experts at the workshop-cum-review meeting in Gaya on Saturday.



सीयूएसबी–बिहार राज्य जैव विविधता बोर्ड की कार्यशाला ● सौजन्य- सीयूएसबी

पर्षद् द्वारा चयनित 12 Knowledge Partner Institutions के साथ छः शहरी क्षेत्रों की जैव विविधता संबंधी अध्ययन कार्य प्रारम्भ किया गया है। इस कार्य में अबतक की प्रगति की समीक्षा एवं संग्रहित सूचनाओं के अदान प्रदान हेतु दक्षिण बिहार केन्द्रीय विश्वविद्यालय, गया के सभागार में दिनांक 16.09.2026 को बैठक आहूत की गयी। समीक्षा बैठक में विश्वविद्यालय के कुलपति एवं पर्षद् के अध्यक्ष द्वारा इसकी महत्ता एवं अध्ययन के परिणामोन्मुखी दिशा हेतु बिन्दुओं को रखा गया तथा सभी संस्थानों ने अबतक की प्रगति को साक्षा किया। इन शोध अध्ययन में नॉलेज पार्टनर्स के रूप में 10 संस्थान प्रतिभागी हैं –NEERI, IIT&ISM Dhanbad, CUSB, NIT Patna, IIHS Bangalore, College of Commerce, Arts and Science, Patna University, BIT Mesra and Patna, CIMP, A N College Patna. कार्यशाला में पटना अर्बन एग्लोमरेशन, गया–बोध गया, भागलपुर, आरा–बक्सर कॉरिडोर, मुजफ्फरपुर, बिहारशरीफ– पावपुरी–राजगीर–नालंदा क्लस्टर के जैव विविधता के अवयवों तथा इकोसिस्टम– एनवायर्नमेंटल सर्विसेज की स्थिति एवं इनसे जुड़े शासनिक–प्रबंधन पहलुओं का आकलन संबंधी आंकड़ों–तथ्यों पर प्रस्तुति और चर्चा की गई।

10. जैव विविधता प्रबंध समितियों को उद्यमिता स्टार्ट–अप से जोड़ने के संबंध में चंद्रगुप्त प्रबंधन संस्थान पटना के बिज़नेस इनक्यूबेशन इन्नोवेशन फैसिलिटी के निदेशक के साथ परामर्श बैठक (21 सितम्बर, 2026)



वनों से संग्रहित जैविक उत्पादों के वाणिज्यिक उपयोग में स्थानीय पंचायतों के जैव विविधता प्रबंध समितियों को उद्यमिता स्टार्ट–अप से जोड़ने के संबंध में चंद्रगुप्त प्रबंध संस्थान पटना के बिज़नेस इनक्यूबेशन इन्नोवेशन फैसिलिटी के निदेशक के साथ परामर्श बैठक का आयोजन पर्षद द्वारा किया गया इस बैठक में जैव विविधता संरक्षण कार्य से जुड़े गैर सरकारी संस्थान Regenerative India के प्रतिनिधि के साथ औषधीय पौधों के उपयोग में संलग्न ग्रामीण व्यक्तियों ने भी अपने विचार व्यक्त किये।

11. कृषि जैव–विविधता अन्तर्गत स्थानीय फल प्रजातियों के संरक्षण हेतु पटना जिले के बड़हिया एवं मोकामा नगर पंचायतों में प्रशिक्षण कार्यशाला (21 एवं 22 सितम्बर, 2026)





जैव विविधता विषय पर पटना जिला अन्तर्गत बड़हिया एवं मोकामा के किसानों के लिए एक दिवसीय कार्यशाला का आयोजन किया गया। इस कार्यशाला में आई०सी०ए०आर०–केन्द्रीय उपोष्ण बागवानी संस्थान, लखनऊ के प्रधान वैज्ञानिक डॉ संजय कुमार सिंह एवं बिहार राज्य जैव विविधता पर्षद्, पटना के वैज्ञानिक पदाधिकारी श्री भावेश कुमार के द्वारा अमरूद, नीबूं, बेल, आँवला एवं कटहल जैसे स्थानीय किस्मों के संरक्षण, जन जैव विविधता पंजी तैयार करने और उपयोगिता, जैव विविधता प्रबंधन समिति के क्रियाकलापों एवं विरासत वृक्ष घोषित करने के लिए प्रक्रिया की जानकारी दी गई।

यह कार्यशाला ICAR-Central Institute of Sub-tropical Horticulture द्वारा बिहार राज्य जैव विविधता पर्षद के समर्थन से चल रहे फलों की देशी प्रजाजियों के संरक्षण हेतु शोध कार्यक्रम के अन्तर्गत सम्पन्न हुई।

12. आईसीएआर क्षेत्रीय स्टेशन, पूसा में जैव–विविधता विरासत स्थल और ऐतिहासिक विरासत वृक्षों की पहचान एवं अध्ययन कार्य (28–29 सितम्बर, 2026)

अध्यक्ष बि.रा.जै.वि. पर्षद् द्वारा परिसर के भ्रमण के क्रम में स्थल की विशिष्टता के आलोक में बुढ़ी गंडक नदी से सटे अंश भाग को जैव विविधता विरासत स्थल घोषित किये जाने हेतु उपयुक्त पाया गया तथा परिसर में कुछ अत्यधिक पुराने एवं विशिष्ट वृक्षों की उपलब्धता भी पायी गयी। उनके निदेश के आलोक में पर्षद् के जी.आई.एस. पदाधिकारी डॉ. जय कुमार द्वारा स्थलीय भ्रमण तथा आईसीएआर के पदाधिकारियों के साथ विमर्श कर स्थल का खाका तैयार किया गया एवं 6 विशिष्ट वृक्षों की पहचान की गयी। निर्धारित प्रक्रियानुसार जैव विविधता विरासत स्थल एवं जैव विविधता विरासत वृक्ष घोषित करने हेतु प्रतिवेदन की प्रक्रिया प्रारम्भ करायी गयी।





Mud Puddling Butterflies

Biodiversity Communications
जैवविविधता संवाद



The Fascinating World of Dung Beetles

Sunanda Kumari*

During a morning biodiversity survey, the hours slipped away without yielding a single notable record. By early afternoon, exhaustion had set in, and I felt a growing sense of disappointment that the day's fieldwork would wrap up empty-handed. Then, a faint disturbance caught my eye. Near a drying pat of herbivore dung, something was moving. Getting down on my knees, I smiled: a dung beetle was busily sculpting a near-flawless sphere of manure with its hind legs, preparing to roll it away. It wasn't the first time I had seen this, I had watched this spectacle since childhood, yet the familiar sight instantly revived all my old questions: What purpose did this dense sphere serve? Why go to such lengths for animal waste? How did the beetle push backward, head bowed toward the ground, without veering hopelessly off course? That afternoon, childhood curiosity converged with scientific inquiry.

The Sheath-Winged Navigator

Dung beetles belong to **Coleoptera**, an order derived from the Greek *koleos* ("sheath") and *pteron* ("wing"). Coleoptera represents roughly 40% of all insect species and a quarter of all described animal life. Their evolutionary success rests largely on their **elytra**, the hardened forewings that shield the delicate flight wings and abdomen from abrasions and desiccation, enabling them to colonize nearly every terrestrial ecosystem outside Antarctica. Within this massive lineage, dung beetles belong to the family Scarabaeidae. Not all members of this family utilize dung; "true dung beetles" belong to the subfamily Scarabaeinae. These beetles shape dung into spherical balls to create a "brood mass" inside which the eggs are laid. While ecological functional groups range from tunnelers (*paracoprids*) to dwellers (*endocoprids*), rollers (*telecoprids*) like ***Gymnopleurus cyaneus*** display the iconic sphere-crafting behavior. These dung beetles are attracted by the pungent odor of fresh dung

from herbivorous animals, and the adults feed on the liquid component of the dung. Adult scarabs rely on flattened, ciliated mouthparts to filter and consume moisture and nutrient-rich microorganisms suspended within fresh dung.

Engineering Life Underground

For reproduction, they shape the dung into a perfect sphere, transport it to a specific nesting site underground. Moving away from the main pile helps them avoid intense competition from hundreds of other beetles arriving at the fresh dung source. They lay eggs on it so the larvae can feed on the dung. A brood mass functions as a nutrient bank and protective shelter for a single offspring. Beetle reproduction tracks food quality: females produce more viable brood masses when livestock graze on lush, protein-rich vegetation compared to coarse, withered forage.Once rolled to a suitable site, the ball is buried in an underground chamber. In many rolling and tunneling species, parenting demands cooperation. Pairs collaborate to excavate the burrow and bury the mass. The female coats the sphere to guard against fungal spores, while the male guards the tunnel entrance against intruders. Males exist in two forms: 'minor' and 'major'.' Some large males (major males) possess horns that assist them in mating, nest-building, and fending off smaller males (minor males). Occasionally, when minor males fail to secure a mate, they stealthily enter the burrow to mate with the female. If the major male discovers this, he often abandons the female and ceases guarding the nest, forcing the female to raise the offspring alone. Although dung beetles typically exhibit biparental care, such abandonment not only affects the offspring but also significantly shortens the female's lifespan, ultimately reducing the species' reproductive rate.

Three Groups

Dung beetles are categorized into three groups based on how they gather and store their 'brood masses':

Paracoprids or Tunnelers

These beetles dig a tunnel beneath the dung pile and use their heads, forelegs, and bodies to break off pieces of dung and transport them down through the tunnel. There, they compress these pieces together to form a solid 'brood mass'. An egg is laid inside this brood mass. Before creating the next 'brood mass' they cover the existing ball with a layer of soil.

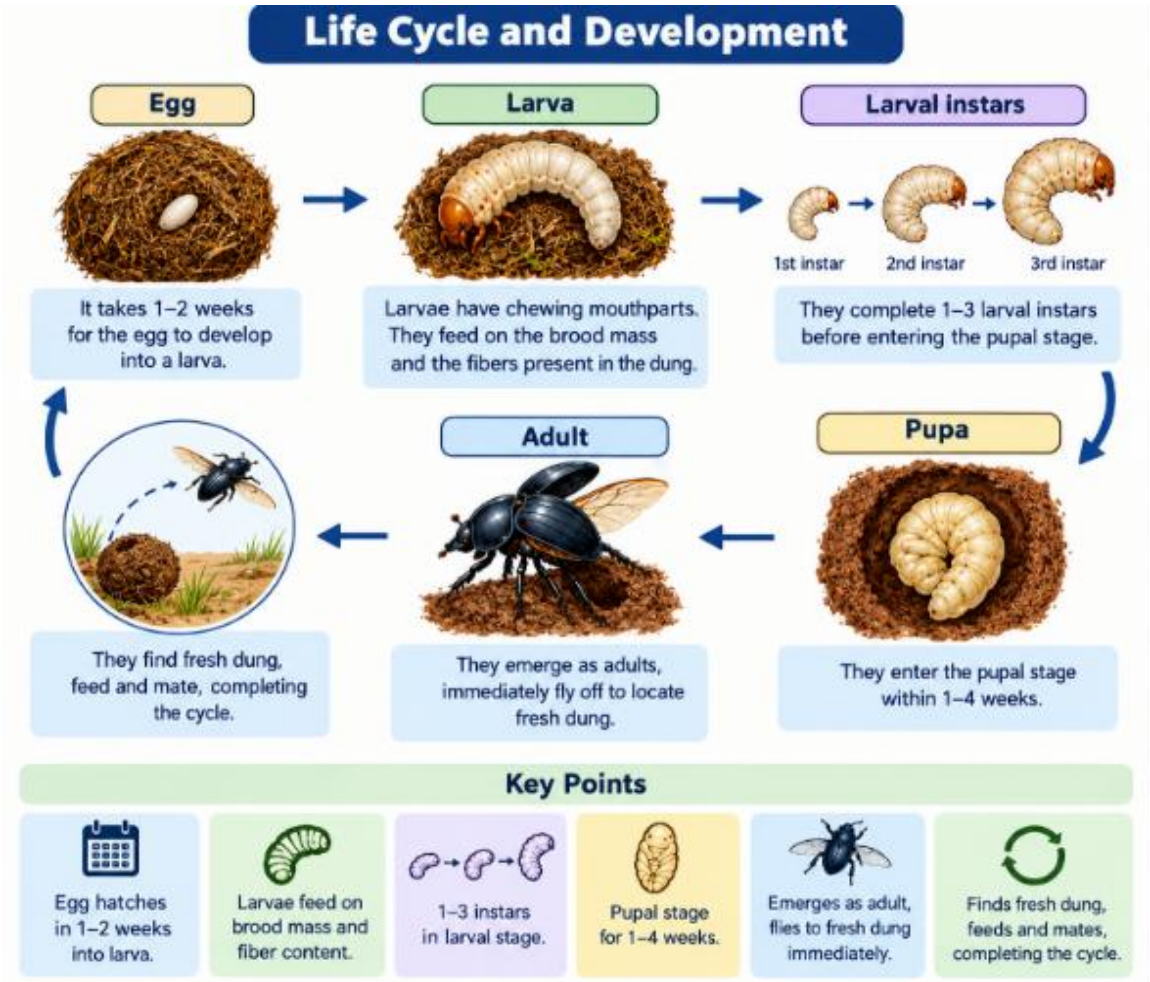
Teleocoprids or Rollers

These beetles form a ball from a dung pile or excrement and typically roll it away using their hind legs; they then bury it in the soil and lay an egg inside.

Endocoprids or Dwellers

These beetles create their 'brood masses' within the cavities inside the dung pile itself.

Life Cycle



Their life cycle is also fascinating; one or two weeks after being laid, the egg hatches into a larva that feeds on the 'brood mass'. Unlike adults, larvae possess biting mouthparts, enabling them to consume the fibrous components of the dung. Larvae generally complete three developmental stages ('instars') over 12 weeks before entering the pupal stage for 1–4 weeks; subsequently, they emerge from the soil in search of fresh dung to eat. **Weight lifters, Stargazers and The Egyptian connection.** The beetle's physical prowess is astonishing, certain scarab species (*Onthophagus taurus*) can pull up to **1,141 times their body weight**, the biomechanical equivalent of an adult human dragging multiple loaded freight trailers. Yet their mental navigation is even more sophisticated. Pushing backward with its head tilted downward, a roller maintains a remarkably straight line. By day, it relies on celestial cues, perceiving patterns of polarized sunlight through specialized ommatidia in its compound eyes. At night, it turns to the stars.

During an Asian Waterbird Census (AWC) in Motihari, a colleague casually referred to them as "stargazers." While scientists long knew insects navigate using solar or lunar polarized light, nocturnal dung beetles presented a puzzle: they rolled in perfectly straight lines even on moonless nights. A landmark 2013 study revealed their secret-they orient using the starry sky, specifically

using the diffuse glow of the **Milky Way** as a celestial compass to steer in the dark. Research famously demonstrated this at the Johannesburg Planetarium: nocturnal dung beetles orient along the faint luminous gradient of the **Milky Way**. When fitted with miniature cardboard caps that blocked their view of the night sky, the beetles lost their bearings and rolled in disoriented circles. This marked the first documented proof of an insect utilizing Milky Way orientation for directional steering. This behavioral sophistication carries vast ecological significance. Ancient Egyptians revered the scarab as an earthly vessel of the deity *Khepri*, viewing its celestial rolling as a symbol of the sun's daily rebirth across the heavens. Their emergence from the soil in autumn symbolizes rebirth, while the way they push dung balls across the ground with their legs mimic the movement of the rising sun across the sky. They crafted amulets shaped like dung beetles and wore them as good-luck charms.

Ecosystem Engineers

Today, we categorize dung beetles as vital **ecosystem engineers** as they help in:

(i) **Soil remediation:** Deep tunneling aerates compacted soil, facilitates root penetration, and dramatically increases rainwater infiltration.

(ii) **Nutrient recycling:** Rapidly burying waste reincorporates nitrogen, carbon, and phosphorus into the soil matrix while dispersing undigested seeds.

(iii) **Biocontrol and sanitation:** By swiftly processing animal deposits, beetles deprive nuisance flies and gastrointestinal parasites of breeding grounds, clearing pastures and sanitizing livestock environments.

Walking away from the survey that afternoon, my earlier disappointment had vanished. In a world preoccupied with scale and speed, this tiny architect offered a grounding lesson: true ecological mastery is not defined by sheer size, but by exquisite adaptation, quiet resilience, and living in precise harmony with the earth.

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*Biodiversity Intern, Bihar State Biodiversity Board



Marorphali in Rocky Hill Tracts of Gaya, Bihar

A native shrub of dry deciduous landscapes; ecological, ethnobotanical and conservation significance

Prateeksha Yadav*

In my short tenure (January – April 2026) with Bihar State Biodiversity Board, I joined the biodiversity survey of few open natural ecosystems and forest areas in Jehanabad, Gaya and Sheikhpura districts. These sites included the Barabar hills, which have the famous caves of the same name. The Barabar hills spread over more than 1000 ha straddling the boundary of Gaya-Jehanbad districts is amongst the prominent boulder-strewn hills and castle koppies found in south Bihar. These open natural ecosystems in dry deciduous landscapes shelter vegetation that are also valued for their medicinal and therapeutic uses. Marorphali is among several such trees and shrubs recorded during my excursions in these tracts, which led me to look for more about this shrub with an unusually interesting pollination system and changing flower coloration.



Barabar Hills (Rocky Outcrops) in Jehanabad – Gaya districts

मरोड़ फली, also known as East Indian Screw Tree, is a native shrub or small tree of seasonally dry tropical vegetation. The botanical name is *Helicteres isora*, and the species is placed in the family Malvaceae under current taxonomic treatment; older Indian floras and some Bihar forest documents place Helicteres under Sterculiaceae. The species is recognizable by its crimson flowers and distinctive cylindrical, spirally twisted fruits. For Bihar, the species is particularly relevant to the dry deciduous vegetation of the southern districts. Official floristic assessments of Bihar record *H. isora* from Kaimur, Aurangabad, Nawada and Jamui, while a published Botanical Survey of India record documents the species from Harnahi forest block, Gaya district. The Bihar Forest Department's floristic study of Kaimur also found *H. isora* to be an important component of the shrub layer. These records provide a strong basis for targeted field documentation in Gaya Division.

Botanical Profile

Scientific name	*Helicteres isora* L.
Family	Malvaceae (Sterculiaceae in older literature)
Abit	Shrub or small tree, commonly 3–8 m
Common names	Marorphali, Marodphali, Aita/Aintha; East Indian Screw Tree
Habitat	Dry deciduous forest, hill slopes, plains and disturbed forest margins
Key field character	Cylindrical follicle, strongly spirally twisted like a screw
Distribution	Native from South Yunnan through tropical Asia; widespread in India

Occurrence and Habitat Context in Gaya, Nalanda, Aurangabad and Nawada

The tracts of Gaya-Jehanabad, Nalanda, Aurangabad and Nawad – part of northern outliers of Chotanagpur formations, contain extensive dry deciduous and hill-associated habitats in which native shrub species form an important structural layer below the tree canopy. *H. isora* is especially relevant where forest is relatively open, seasonally dry and associated with rocky or sloping terrain. The published Harnahi record is important because it confirms the species in a Gaya forest locality rather than only in neighboring districts.



The species is also listed among the shrubs of the Rajgir Wildlife Sanctuary in Nalanda district and adjoining forest biodiversity inventory, showing its representation within Bihar's dry and semi-dry forest vegetation. For Gaya district, however, present-day abundance, regeneration and population structure should be established through fresh field surveys rather than inferred solely from historical records.

Morphological Features

Helicteres isora is a shrub or small tree with a generally greyish to brownish bark and hairy young branches. Leaves are simple, relatively large, broadly elliptic to ovate or cordate, and may show shallow lobing. Flowers are axillary, solitary or clustered, with conspicuous reddish to crimson petals. The flower structure is robust and zygomorphic, with the staminal column and gynophore forming a distinctive arrangement.



The fruit is the most diagnostic field character. It is a cylindrical follicle, usually several centimetres long, and becomes strongly twisted or spiralled at maturity. The numerous small seeds are enclosed within the dry fruit. Because the fruit shape is so distinctive, the species can be readily verified during biodiversity surveys even when flowering has ceased.



Leaf arrangement and Flower arrangement of *Helicteres isora* (eFlora of India)

Pollination Ecology and Plant–Animal Interactions

H. isora has an unusually interesting pollination system. Classical pollination research reports that flowers open in the early morning and remain functional for several days. Flowers are short lived, typically persisting for about three days, over which they undergo a well-documented sequence of colour transition, a bluish-grey coloration on the first day, a lighter red on the second day, and a darker red by the third day. And a distinct colour change towards purplish-blue following successful pollination. This feature helps pollinators to discriminate between rewarding and non-rewarding flowers while allowing the plant to maintain a large, visually attractive floral display for longer periods. Field observation on *H. isora* recorded a remarkably high diversity of floral visitors. In one such study, twenty- five species of nectar-feeding birds spanning twelve avian families were documented visiting the plant over a relatively short observation period. Studies have recorded both birds and insects as flower visitors. Bird visitors, including babblers and mynas, have also been reported to transfer pollen between flowers. Other observational work has documented sunbirds, bulbuls, and other insects visiting the flowers.

Sunbirds (Family Nectariniidae) - are considered the primary pollinators of *H. Isora.* Bees, including carpenter bees, show a contrasting pattern of visitation, concentrating their activity on the newly opened, bluish-grey flowers, from which they collect both nectar and pollen. This distinction is ecologically significant: because birds tend to visit the older, redder flowers, while bees visit the younger, greyer ones. This means the plant isn't putting all its reproductive success in one basket-if birds are scarce on a given day, bees can still help pollination occur. This multi-visitor system makes *H. isora e*cologically relevant as a component of plant–pollinator networks. It should not be assumed that every flower visitor is an effective pollinator; rather, the species provides an excellent opportunity for local observation of nectar feeding, pollen collection, flower handling and pollen transfer.

(i) **Ecological and Biodiversity Significance** Supports plant–pollinator interactions involving bees, birds and other flower-visiting organisms.

(ii) Contributes to the diversity and structural complexity of the shrub layer in dry deciduous forests.

(iii) A flowering resource within seasonally dry landscapes when continuity of floral resources can be important for pollinators.

(iv) Participates in reproductive interactions that enable seed production and maintenance of local plant populations.

(v) Acts as a native component of forest communities and therefore has value beyond its medicinal or ethnobotanical uses.

(vi) A useful focal species for documenting plant–animal interactions in biodiversity-rich forest mosaics of southern Bihar.

Ethnobotanical and Local Importance

H. isora has a long history of traditional use in South Asian systems of medicine. Kew's medicinal plant database records use of fruits, roots, bark and leaves in traditional sources. Indian Biodiversity Portal records the species as a medicinal plant and notes fibre from the bark and use of the wood as fuel. In Bihar, ethnobotanical literature has documented the species among locally used plants, including records from southern Bihar.

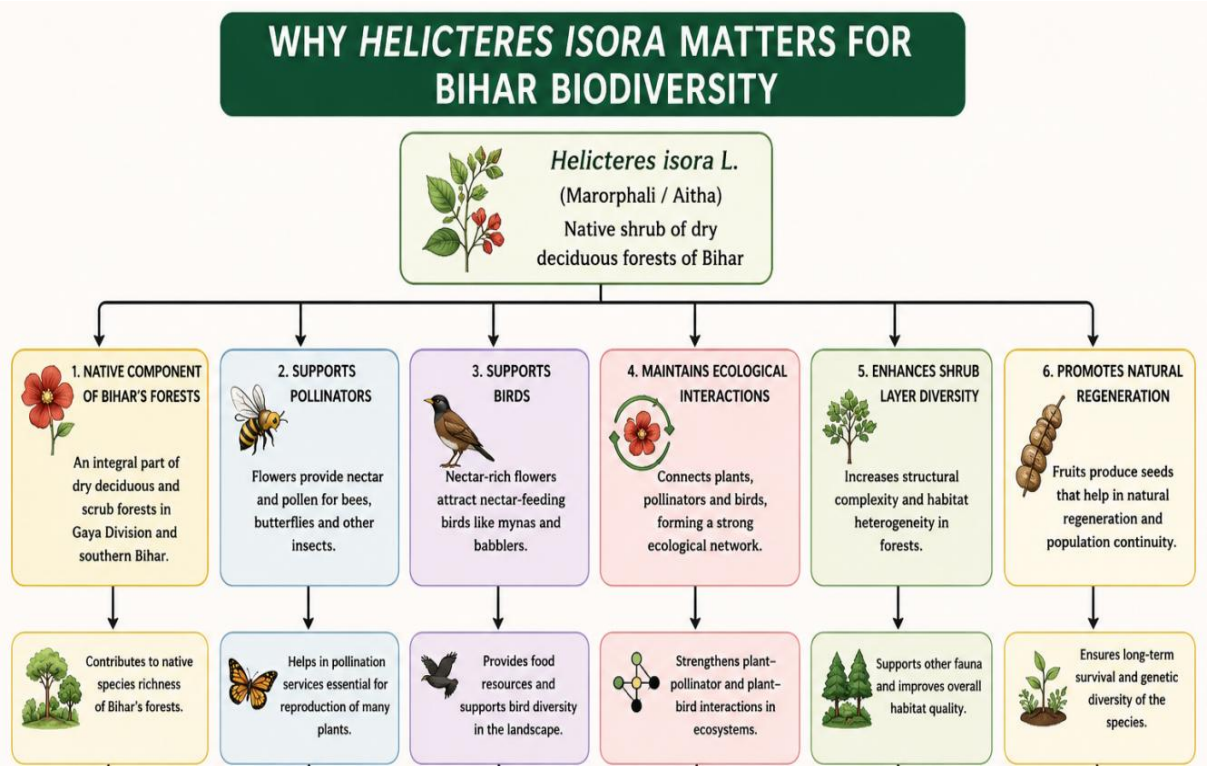
For biodiversity documentation, ethnobotanical information should be recorded alongside ecological observations, while respecting community knowledge and applicable access-and-benefit-sharing requirements.

The objective should be documentation and conservation rather than encouraging unsustainable extraction from wild populations.

Conservation Value

The conservation value of *H. isora* lies in its role as part of an interconnected forest community. Protecting the species in isolation is less useful than maintaining the habitat, associated native shrubs, flowering plants, pollinator communities and natural regeneration processes with which it occurs.

Conservation Action



A practical conservation programme should combine documentation, habitat protection, propagation and community participation.

The first step is to locate and verify existing wild populations in Gaya and adjoining Forest Divisions.

Permanent or revisited plots can then be established at representative sites to track survival, flowering, fruiting and recruitment. Such monitoring will provide a stronger evidence base for future conservation decisions than isolated occurrence records.

Propagation can be integrated with restoration where natural regeneration is inadequate. Seed-based multiplication may be used for general planting, while locally sourced material should be preferred for restoration of wild populations. Nursery-raised plants can be introduced into suitable native-vegetation restoration sites, especially along degraded forest edges and ecological corridors, provided that site selection is based on habitat suitability.

Creating monoculture plantations of *H. isora.* has to be avoided. Its biodiversity value is achieved when it is maintained as one component of a diverse native plant community containing trees, shrubs, herbs, climbers and natural pollinator habitat.

Conclusion

Marorphali *(Helicteres isora* L.*)* is a distinctive native shrub/small tree with clear ecological relevance to the dry deciduous landscapes of Bihar. Its documented occurrence in southern Bihar and specifically at Barabar hill in Gaya district makes it a suitable focal species for biodiversity documentation in Gaya Division. Its value is not limited to ethnomedicine: its flowers participate in interactions with bees, birds and other flower visitors, while the species contributes to native shrub-layer diversity and forest ecological structure.

H. isora offers a practical species through which local biodiversity can be documented at several levels: plant distribution, habitat association, phenology, pollination ecology, regeneration, ethnobotanical knowledge and conservation status. A systematic Gaya Division survey would help determine its current distribution and population condition and could provide baseline information for future monitoring and habitat restoration.

The recommended conservation approach is therefore habitat-based and evidence-driven: map wild populations, monitor regeneration and flowering, document plant–pollinator interactions, protect native forest habitat, and use locally sourced planting material where restoration is required. Such an approach recognizes *H. isora* as a functional part of a region's biodiversity rather than merely as a medicinal plant.

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Ex-Young Professional, Bihar State Biodiversity Board References



(Maharukh, Hijal, Rudravanti, Jungli Palak, Jalbet, Tumari/Panigamhar in clockwise from top-left)

Riparian Saviours

The Native Plants That Stand Between a River and a Vanishing Bank

Dr. Punam Ranjan*

Six native plants, six ecological stories

A river is never only water. Along its edge lies a living belt of trees, shrubs and herbs that quietly holds soil together, catches freshly deposited silt, shelters wildlife and helps the floodplain recover after disturbance. In the Indo-Gangetic Plain, where rivers continually reshape their banks and floodplains, this vegetation can be the difference between a stable living bank and an exposed, eroding one. These plants may be called "riparian saviours"— not because every species performs the same job, but because each occupies a particular ecological niche in the flood–sediment–vegetation cycle.

The idea becomes especially important in *Indo-Gangetic floodplain* of Bihar. As floods bring destruction, they also bring fine alluvial sediments and nutrients. Where native vegetation survives or quickly returns, roots bind the deposited material, stems slow water close to the ground, and fallen leaves feed the soil. Over time, a bare or newly silted surface can become a functioning habitat again. Some species are adapted to wet river margins and flowing water; others belong to higher floodplain edges, damp fields or newly exposed sandy ground. Together they form a living mosaic.

1. PANI GAMHAR / TUMARI - the big floodplain builder


Pani Gamhar

Trewia nudiflora commonly known as Pani Gamhar, Tumari and Pindara, this native large deciduous tree is a member of the Euphorbiaceae. It has broad, often glaucous-backed leaves, separate male and female plants, pale-green flowers and distinctive rounded woody capsules. In wet and river-associated landscapes, its large root system and substantial canopy make it more than a tree: perform as a structural element of the floodplain. The substantial root system contributes to soil binding and bank stabilization, while its canopy provides structural habitat for birds, insects and other organisms. It has high potential as a structural riparian tree: bank reinforcement, shade, litter input, habitat formation and recovery of floodplain vegetation.

2. JALBET - the riverbank specialist


Jalbet

Homonoia riparia, known as the jalbet or jalavetasa or willow-leaved water croton, "Sherni", of Euphorbiaceae family is one species in this group that most clearly embodies the word "riparian". This dioecious shrub or small tree is strongly associated with streams and riverbanks and is regarded as a ***rheophytic*** plant—one adapted to habitats influenced by flowing water. Its narrow, willow-like leaves, spike-like inflorescences and three-lobed fruits are useful field clues. Dense root systems can anchor loose substrates, while clumps of vegetation slow near-bank flow and trap fine sediment. The plant also creates low-level shelter and microsites for other organisms. This makes it a particularly compelling native candidate for natural bank protection and floodplain recovery.

3. HIJJAL - the wetland specialist


Hijjal

Barringtonia acutangular (Hijjal) of the Lecythidaceae family is one of the strongest candidates for a riparian-saviour story. It is a medium-sized tree associated with wet habitats, riverbanks and water bodies. Its terminal leaves, pendulous flower racemes, brilliant scarlet flowers with numerous long stamens and angular fruits make it easy to recognize when in season. Growing where water is part of the landscape, it can help consolidate wet alluvial substrates, provide shade and vertical habitat, add leaf litter and support food webs. In restoration, it offers a useful bridge between river edge, wetland and floodplain vegetation.

4. JUNGLI PALAK - the ground-level guardian


Jungli palak, the ground-level guardian taking the lead over water hyacinth when water level is reduced

A riparian ecosystem is not protected by trees alone: the herb layer is the living skin of the bank. Jungli Palak or bearded knotweed ***(Persicaria barbata)*** of Polygonaceae family, works at a much smaller scale. It is a perennial herb with narrow lanceolate leaves and a characteristic long-ciliate, "bearded" ochrea around the stem nodes. It bears pale flowers in slender racemes and the fruit is a dry, three-angled achene. Along streams and river margins, such herbs may form an important ground layer. They cover exposed soil, reduce splash and surface erosion, retain moisture and provide shelter for small invertebrates and microorganisms.

5. RUDRAVANTI - the pioneer / early successor of open ground


Rudravanti

Rudravanti (***Cressa cretica***) of Convolvulaceae family tells a different story. It is a small, densely branched perennial subshrub with tiny hairy leaves and small white to whitish-pink flowers. It is associated with sandy, seasonally wet and sometimes saline or alkaline habitats. Its direct bank-binding power is much smaller than that of a large tree or other shrubs, but that is precisely why it is interesting. On newly exposed or disturbed ground, pioneer plants can provide the first living cover and help begin ecological succession. In a floodplain that is repeatedly stripped, buried and rebuilt, even a small pioneer can be part of the recovery machinery.

6. MAHARUKH - a floodplain-margin survivor


Maharukh

Ailanthus excelsa (Maharukh or Ghorneem or Ghurikaram), of Simaroubaceae family, is a native tall, fast-growing tree with very large pinnate leaves, rough grey-brown bark, small greenish-yellow flowers and winged fruits. Not a specialist permanently waterlogged riverbank tree, but valued for elevated or better-drained floodplain margins and riparian–agricultural transition zones, where rapid growth, vegetation cover and roots can contribute to soil retention and habitat.

These six plants are constituents of ***living defense system***, not just individual plant species. Seen together, the six plants and other trees, shrubs and herbs with similar attributes together reveal why "riparian saviour" should be understood as a functional idea.

- Jalbet can occupy the active river edge; Hijjal can thrive in wet environments; Tumari can add large-tree structure; Jangali palak can protect the ground layer; Rudrawanti can pioneer exposed substrates; and Maharukh may contribute on relatively elevated floodplain margins.
- Their roles overlap, but they are not completely interchangeable with varied ecological functions in addition to erosion control. Riparian vegetation intercepts sediment, creates shade and microclimates, contributes carbon and organic matter, recycles nutrients and provides nesting, feeding and shelter sites for birds, insects, amphibians and other fauna.

A vegetated bank function as both habitat and infrastructure — illustrative of nature-based protection in which ecological recovery and physical stability reinforce one another.

Let's save the ecological saviors in river bank fringes and floodplains!

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(Co-PI PUA - *Urban Biodiversity Studies* Project, BSBB)
Photos: Author - Tumari, Maharukh, Jalbet, Jungli palak and Rudrawanti); Riya Raj, Intern BSBB - Hijjal tree



बिहार की पशुधन जैव विविधता: महत्व एवं वर्तमान परिदृश्य

डॉ. पंकज कुमार, डॉ. राखी भारती एवं डॉ. सरोज कुमार रजक*

पशुधन भारतीय कृषि प्रणाली का अभिन्न अंग है। कृषि एवं पशुपालन एक-दूसरे के पूरक हैं तथा ग्रामीण अर्थव्यवस्था की स्थिरता में महत्वपूर्ण भूमिका निभाते हैं। बिहार में लगभग प्रत्येक ग्रामीण परिवार किसी न किसी रूप में गोवंश, भैंस, बकरी, भेड़, सूकर अथवा कुक्कुट पालन से जुड़ा हुआ है। इन पशुओं की विभिन्न नस्लें राज्य की आनुवंशिक संपदा का प्रतिनिधित्व करती हैं, जिसे सामूहिक रूप से **पशुधन जैव विविधता (Livestock Biodiversity)** कहा जाता है। स्थानीय नस्लों ने सदियों तक प्राकृतिक चयन एवं किसान चयन (Farmer Selection) के माध्यम से स्थानीय जलवायु, रोगों, चारा संसाधनों एवं कृषि प्रणाली के अनुरूप स्वयं को विकसित किया है। यही कारण है कि देशी नस्लें कठिन परिस्थितियों में भी बेहतर अनुकूलन क्षमता, रोग प्रतिरोध एवं कम लागत पर उत्पादन की विशेषता रखती हैं।

पशुधन जैव विविधता (Livestock Biodiversity)

जैव विविधता (Biodiversity) से अभिप्राय पृथ्वी पर उपलब्ध समस्त जीवधारियों, उनके आनुवंशिक संसाधनों तथा पारिस्थितिक तंत्रों की विविधता से है। यह किसी क्षेत्र की पारिस्थितिक स्थिरता, प्राकृतिक संसाधनों की निरंतरता एवं सतत् विकास का आधार है। बिहार में पशुपालन ग्रामीण अर्थव्यवस्था का महत्वपूर्ण आधार है। पशुधन जैव विविधता से आशय पालतू पशुओं एवं पक्षियों की विभिन्न प्रजातियों तथा उनकी नस्लों में उपलब्ध आनुवंशिक विविधता से है। इसमें केवल पशुओं की संख्या ही नहीं, बल्कि उनकी उत्पादन क्षमता, अनुकूलन शक्ति, रोग प्रतिरोध, प्रजनन क्षमता एवं व्यवहारगत विशेषताएँ भी सम्मिलित होती हैं।

बिहार में प्रमुख पशुधन एवं कुक्कुट आबादी

पशुधन वर्ग	संख्या, 20वीं पशुधन जनगणना (2019)	बिहार के लिए प्रमुख महत्व
गोवंश	1.54 करोड़	दूध, कृषि सहयोग, जैविक खाद
भैंस	77.20 लाख	दुग्ध उत्पादन एवं उच्च वसा वाला दूध
बकरी	1.28 करोड़	छोटे किसानों की आय एवं मांस
भेड़	2.13 लाख	मांस एवं पारंपरिक ऊन उत्पादन
सूकर	3.43 लाख	मांस एवं आजीविका
कुक्कुट	1.65 करोड़	अंडा, मांस एवं घरेलू आय

बिहार की पशुधन जैव विविधता का आर्थिक योगदान

क्षेत्र	प्रमुख योगदान
दुग्ध उत्पादन	ग्रामीण आय एवं पोषण
बकरी पालन	सीमांत किसानों की आय
कुक्कुट पालन	महिला सशक्तिकरण एवं पोषण
भैंस पालन	उच्च वसा युक्त दूध
गोवंश	दूध, जैविक खाद एवं कृषि सहयोग
भेड़ पालन	मांस एवं ऊन



बछौर



सहीवाल



मुर्रा



ब्लैक बंगाल



बीटल



शाहाबादी



वनराजा



कड़कनाथ

बिहार में पशुधन का महत्व

बिहार में पशुधन केवल आय का स्रोत नहीं बल्कि ग्रामीण जीवन का अभिन्न अंग है। कृषि आधारित परिवारों के लिए पशुपालन नकद आय, पोषण, जैविक खाद, ऊर्जा एवं रोजगार उपलब्ध कराता है।

पशुधन के प्रमुख योगदान

(i) दुग्ध उत्पादन एवं पोषण सुरक्षा
(ii) मांस एवं अण्डा उत्पादन
(iii) जैविक खाद एवं मृदा उर्वरता
(iv) कृषि कार्य एवं परिवहन (जहाँ लागू)
(v) महिलाओं एवं भूमिहीन परिवारों की आय
(vi) ग्रामीण रोजगार एवं उद्यमिता
(vii) जोखिम प्रबंधन एवं सामाजिक सुरक्षा

बिहार की कृषि-जलवायु परिस्थितियाँ एवं पशुधन पालन

बिहार की भौगोलिक एवं जलवायु विविधता विभिन्न पशुधन नस्लों के विकास के लिए अनुकूल है। उत्तर बिहार का बाढ़ प्रभावित क्षेत्र, दक्षिण बिहार का मैदानी क्षेत्र तथा दक्षिण-पश्चिमी पठारी क्षेत्र पशुधन पालन की भिन्न-भिन्न परिस्थितियाँ प्रस्तुत करते हैं।

प्रमुख कृषि-जलवायु क्षेत्र

कृषि-जलवायु क्षेत्र	प्रमुख विशेषताएँ	उपयुक्त पशुधन
उत्तर-पश्चिम जलोढ़ मैदान	उपजाऊ भूमि, मध्यम वर्षा	गोवंश, भैंस
उत्तर-पूर्व जलोढ़ मैदान	अधिक वर्षा, आर्द्र जलवायु	बकरी, गोवंश
दक्षिण बिहार मैदानी क्षेत्र	मध्यम वर्षा, सिंचित कृषि	डेयरी पशुधन
दक्षिण-पश्चिम पठारी क्षेत्र	अपेक्षाकृत शुष्क, वन क्षेत्र	बकरी, भेड़

बिहार की प्रमुख पशुधन आनुवंशिक संपदा

पशुधन वर्ग	प्रमुख नस्लें
गोवंश	बछौर, पूर्णिया, गंगातीरी, गिर, साहीवाल, लाल सिंधी, थारपारकर,
भैंस	स्थानीय भैंस, मुर्रा, निली-रावी
बकरी	ब्लैक बंगाल, बीटल, बरबरी, जमुनापारी, सिरोही
भेड़	शाहाबादी, छोटानागपुरी, स्थानीय भेड़
कुक्कुट	असील, कड़कनाथ, ग्रामप्रिया, वनराजा, जापानी बटेर

पशुधन जैव विविधता का महत्व

आर्थिक महत्व

- ग्रामीण आय का प्रमुख स्रोत
- डेयरी एवं पशुधन आधारित उद्यमिता
- रोजगार सृजन

पोषण महत्व

- दूध, मांस एवं अण्डे द्वारा उच्च गुणवत्ता प्रोटीन
- सूक्ष्म पोषक तत्वों की उपलब्धता

पारिस्थितिक महत्व

- जैविक खेती को बढ़ावा
- पोषक तत्वों का पुनर्चक्रण
- प्राकृतिक संसाधनों का संतुलित उपयोग

सामाजिक एवं सांस्कृतिक महत्व

- ग्रामीण जीवन शैली का अभिन्न अंग
- पारंपरिक पशुपालन ज्ञान का संरक्षण
- धार्मिक एवं सांस्कृतिक आयोजनों में उपयोग

देशी नस्लों की प्रमुख विशेषताएँ

विशेषता	लाभ
स्थानीय जलवायु अनुकूलन	चरम तापमान में भी उत्पादन
रोग प्रतिरोध	उपचार लागत में कमी
कम गुणवत्ता वाले चारे का उपयोग	कम उत्पादन लागत
लंबी उत्पादक आयु	अधिक आर्थिक लाभ
बेहतर प्रजनन क्षमता	नियमित उत्पादन
कम रखरखाव	छोटे एवं सीमांत किसानों के लिए उपयुक्त

बिहार की पशुधन जैव विविधता के समक्ष प्रमुख चुनौतियाँ

चुनौती	संभावित प्रभाव
अनियंत्रित संकरण	देशी नस्लों की आनुवंशिक शुद्धता में कमी
चारागाहों का क्षरण	पोषण संकट
जलवायु परिवर्तन	उत्पादन एवं प्रजनन पर प्रभाव
संक्रामक रोग	उत्पादकता में कमी
शहरीकरण	पशुपालन क्षेत्र में कमी
पारंपरिक ज्ञान का लोप	नस्ल संरक्षण में कठिनाई
सीमित अभिलेखीकरण	नस्ल पहचान एवं सुधार में बाधा

पशुधन जैव विविधता के समक्ष उभरती चुनौतियाँ

वर्तमान समय में बिहार की देशी पशुधन नस्लें अनेक सामाजिक, आर्थिक एवं पर्यावरणीय चुनौतियों का सामना कर रही हैं। यदि समय रहते संरक्षण के उपाय नहीं अपनाए गए, तो कई स्थानीय आनुवंशिक संसाधनों के लुप्त होने की संभावना बढ़ सकती है।

चुनौतियाँ एवं समाधान

चुनौती	प्रभाव	संभावित समाधान
अनियंत्रित संकरण (Indiscriminate Crossbreeding)	शुद्ध देशी नस्लों का क्षरण	नस्लवार प्रजनन कार्यक्रम एवं रिकॉर्डिंग
चारागाहों में कमी	पोषण संकट	चारागाह विकास एवं चारा बैंक
जलवायु परिवर्तन	उत्पादन एवं प्रजनन में कमी	जलवायु-अनुकूल देशी नस्लों का संरक्षण
संक्रामक रोग	मृत्यु एवं आर्थिक हानि	नियमित टीकाकरण एवं जैव सुरक्षा
किसानों में जागरूकता की कमी	स्थानीय नस्लों की उपेक्षा	प्रशिक्षण एवं विस्तार कार्यक्रम

चुनौती	प्रभाव	संभावित समाधान
बाजार असंगठन	कम लाभ	मूल्य संवर्धन एवं किसान उत्पादक संगठन (FPO)
आनुवंशिक अभिलेखीकरण का अभाव	नस्ल पहचान में कठिनाई	डिजिटल डेटाबेस एवं जीनोमिक रिकॉर्डिंग

पशुधन जैव विविधता संरक्षण की रणनीतियाँ

In-situ संरक्षण - नस्लों का उनके प्राकृतिक आवास एवं पारंपरिक पालन क्षेत्र में संरक्षण।

उदाहरण

(i) बछौर गोवंश – मिथिला क्षेत्र
(ii) गंगातीरी – गंगा तटीय क्षेत्र
(iii) ब्लैक बंगाल बकरी – सीमांचल एवं उत्तर बिहार

लाभ

(i) प्राकृतिक चयन बना रहता है।
(ii) स्थानीय आनुवंशिक गुण सुरक्षित रहते हैं।
(iii) कम लागत।

Ex-situ संरक्षण - प्राकृतिक क्षेत्र से बाहर वैज्ञानिक संस्थानों में संरक्षण।

उदाहरण

(i) वीर्य संरक्षण
(ii) भ्रूण संरक्षण
(iii) जर्मप्लाज्म बैंक
(iv) Frozen Semen Bank
(v) Cryopreservation

पशुधन संरक्षण हेतु प्रमुख संस्थाएँ

संस्था	प्रमुख कार्य
ICAR	पशुधन अनुसंधान एवं नीति निर्माण
ICAR-NBAGR, करनाल	नस्ल पंजीकरण एवं आनुवंशिक संरक्षण
Department of Animal Husbandry & Dairying	राष्ट्रीय पशुधन विकास कार्यक्रम
Bihar Animal Sciences University	शिक्षा, अनुसंधान एवं विस्तार
Bihar State Biodiversity Board	जैव विविधता संरक्षण
State Animal Husbandry Department	राज्य स्तरीय पशुधन विकास

बिहार में संचालित प्रमुख पशुधन विकास कार्यक्रम

योजना	उद्देश्य
राष्ट्रीय गोकुल मिशन (RGM)	देशी गोवंश संरक्षण एवं संवर्धन
राष्ट्रीय पशुधन मिशन (NLM)	पशुधन आधारित आजीविका
राष्ट्रीय डेयरी विकास कार्यक्रम (NPDD)	डेयरी अवसंरचना विकास
Rashtriya Krishi Vikas Yojana (RKVY)	कृषि एवं पशुपालन विकास
Livestock Health & Disease Control	रोग नियंत्रण
Artificial Insemination Programme	नस्ल सुधार
e-Gopala App	डिजिटल पशुधन प्रबंधन

बिहार में पशुधन जैव विविधता संरक्षण हेतु कार्य प्राथमिकता

1. सभी स्थानीय नस्लों का वैज्ञानिक सर्वेक्षण।
2. नस्लवार डिजिटल डेटाबेस तैयार करना।
3. शुद्ध नस्ल प्रजनन केन्द्रों की स्थापना।
4. ग्राम स्तरीय Breed Conservation Groups का गठन।
5. कृत्रिम गर्भाधान एवं जीनोमिक चयन का विस्तार।
6. पशुपालकों का नियमित प्रशिक्षण।
7. देशी दुग्ध एवं मांस उत्पादों का ब्रांडिंग एवं मूल्य संवर्धन।
8. People's Biodiversity Register (PBR) में स्थानीय नस्लों का समावेश।
9. प्रत्येक जिले में पशुधन जैव विविधता उद्यान (Livestock Biodiversity Park) की स्थापना।
10. विद्यालयों एवं महाविद्यालयों में जैव विविधता जागरूकता कार्यक्रम।

निष्कर्ष

बिहार की पशुधन जैव विविधता केवल गाय, भैंस, बकरी, भेड़ या मुर्गियों की अलग-अलग नस्लों की सूची नहीं है। यह किसान, पशु, जलवायु, चारा, संस्कृति और ग्रामीण अर्थव्यवस्था के बीच सदियों से विकसित संबंधों की जीवित अभिव्यक्ति है। आज जब जलवायु परिवर्तन, नई पशु बीमारियाँ, चारे की कमी और कृषि में तेजी से हो रहे बदलाव हमारे सामने हैं, तब स्थानीय आनुवंशिक संसाधनों का महत्व और बढ़ गया है। हो सकता है कि कोई स्थानीय नस्ल आज व्यावसायिक उत्पादन की दृष्टि से सबसे आगे न हो। लेकिन उसमें मौजूद कोई विशेष गुण—गर्मी सहने की क्षमता, रोग प्रतिरोध, कम चारे में जीवित रहने की क्षमता या स्थानीय पर्यावरण के प्रति अनुकूलन—कल की पशुधन अर्थव्यवस्था के लिए अत्यंत मूल्यवान हो सकता है। इसलिए बिहार के लिए पशुधन जैव विविधता संरक्षण का मूल मंत्र होना चाहिए—"स्थानीय नस्लों को केवल बचाएँ नहीं, उन्हें पहचानें, उनका वैज्ञानिक मूल्यांकन करें, आर्थिक रूप से उपयोगी बनाएँ और आने वाली पीढ़ियों के लिए सुरक्षित करें।" क्योंकि आज बचाया गया एक स्थानीय पशु केवल एक पशु नहीं है—वह आने वाले कल के लिए सुरक्षित किया गया एक आनुवंशिक विकल्प है। स्थानीय पशुधन नस्लों का संरक्षण केवल सरकारी प्रयासों से संभव नहीं है। इसके लिए वैज्ञानिक संस्थानों, राज्य सरकार, पंचायतों, पशुपालकों तथा स्थानीय समुदायों की सहभागिता आवश्यक है।

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Clinical Significance, Biodiversity, and Ecological Conservation of Leech Therapy in Indian Medicine

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Abstract

Leech therapy, known as ***Jalaukavacharana***, is an important bloodletting procedure in Ayurveda under *raktamokshana*. It mainly uses non-poisonous leeches to remove blood and also allows the medicinal substances present in their saliva to act on the body. In recent years, however, rising temperatures, irregular rainfall, wetland destruction, and uncontrolled leech collection have become major threats to their natural populations. This review focuses on the clinical uses of *Jalaukavacharana*, the diversity of medicinal leeches, the pharmacological importance of their salivary secretions, and possible approaches for their conservation and cultivation.

1. Introduction and Historical Context

Leech therapy, or *Jalaukavacharana*, is one of the traditional methods of *Raktamokshana* (bloodletting) described in Ayurveda. Its use dates back to ancient times, and Ayurvedic literature mentions the practice, particularly in the Sushruta Samhita, which includes a separate chapter on *Jalauka*. Sushruta described *Jalaukavacharana* as a relatively gentle method of bloodletting, especially useful when a milder approach was preferred.

The use of leeches was not limited to India. Historical evidence shows that leech therapy was also practiced in ancient Egypt and later became known in Greek, Roman, Arab and European medical traditions. Over the centuries, it was used for different conditions, mainly with the idea of removing excess or

unhealthy blood. During the 18th and 19th centuries, its use became particularly widespread in Europe, to such an extent that very large numbers of leeches were collected and used.

In Ayurveda, *Jalaukavacharana* has a specific place among the methods of *Raktamokshana*. According to Ayurvedic principles, *Jalauka* is considered particularly suitable in conditions involving *Pitta* and vitiated *Rakta*, because of its aquatic nature and the qualities attributed to it. This makes the procedure different from more invasive methods of bloodletting.

With the development of modern medicine, the popularity of leech therapy gradually declined, especially during the 19th and early 20th centuries. However, it did not disappear completely. Its use started gaining attention again in the later part of the 20th century, particularly in reconstructive and microsurgery, where leeches were found useful for managing venous congestion. This renewed interest also led to further scientific study of leech saliva and its biologically active substances.

Thus, *Jalaukavacharana* represents an interesting link between traditional Ayurvedic knowledge and present-day medical research. What was described centuries ago as a method of *Raktamokshana* is now being studied from a modern scientific perspective as well.

2. Biodiversity, Classification, and Regional Distribution

Leeches, classified under the phylum Annelida and class Hirudinea, are segmented aquatic organisms.

तत्र सविषा निर्विषाश्च;
सविषाः षट्, तावत्य एव निर्विषाः ॥

(Sushrut sutrasthan- 13/10)

A. Poisonous Varieties (Savisha Jalauka):

तत्र सविषाः कृष्णा कर्बुरा अलगर्दा इन्द्रायुधा सामुद्रिका गोचन्दना चेति।तासु अञ्जनचूर्णवर्णा पृथुशिराः कृष्णा; वर्मिमत्स्यवदायता छिन्नोन्नतकुक्षिः कर्बुरा; रोमशा महापार्श्वा कृष्णमुखी अलगर्दा; इन्द्रायुधवदूर्ध्वराजिभिश्चित्रा इन्द्रायुधा; ईषदसितपीतिका विचित्रपुष्पाकृतिचित्रा सामुद्रिकाः; गोवृषणवदधोभागे द्विधाभूताकृतिरणुमुखी गोचन्दनेति।ताभिर्दष्टे पुरुषे दंशे श्वयथुरतिमात्रं कण्डूर्मूर्च्छा ज्वरो दाहश्छर्दिर्मदः सदनमिति लिङ्गानि भवन्ति। तत्र महागदः पानालेपननस्यकर्मादिषूपयोज्यः। इन्द्रायुधादष्टमसाध्यम्। इत्येताः सविषाः सचिकित्सिता व्याख्याताः॥

(सुश्रुत संहिता - सूत्रस्थान, जलौकावचारणीय अध्याय - 13/11)

1. **Krishna Jalauka (Hirudo detrimental):** It is black in colour and has a relatively large head.
2. **Karbura Jalauka:** It has a grey, fish-like appearance with a clearly segmented abdomen.
3. **Algarda Jalauka:** This variety is characterised by a hairy body and broad flanks.
4. **Indrayudha Jalauka:** It can be identified by the longitudinal stripes present along its back.
5. **Samudrika Jalauka**: It has a blackish-yellow colour with distinct flower-like patterns on the body.
6. **Gochandana Jalauka:** It has a divided or bifurcated lower body and a comparatively small mouth.

Note: *Application of poisonous varieties can induce localized swelling, severe itching, fever, burning sensations, vomiting, fainting, and myalgia, whereas non-poisonous varieties cause no such toxic complications.*

B. Key Aquatic Habitats and Regional Distribution:



In India, medicinal leeches are mainly found in wetland areas and freshwater habitats, particularly in slow-moving water bodies, floodplains, ponds, and oxbow lakes known locally as chaurs. In Bihar, several regions provide such suitable natural habitats.

North Bihar: Medicinal leeches are reported from the floodplains of the Kosi basin, including Madhubani, Supaul, and Saharsa. They are also found in ponds around Darbhanga and in the marshy areas of Muzaffarpur, Sitamarhi, and Champaran.





Central and South Bihar: Important habitats include the Ganga River basin around Patna and Kanwar Lake in Begusarai, which is among the largest freshwater oxbow lakes in Asia. Seasonal wetlands and forest streams in areas such as Nalanda, Gaya, Jamui, and Banka also provide suitable freshwater environments for leeches.

3. Clinical Indications and Workflow

Therapeutic Indications:

(i) Vascular and inflammatory conditions: *Jalaukavacharana* has been used in conditions such as varicose veins, deep vein thrombosis, gout, haemorrhoids, sprains, and local inflammation.



Leech therapy on Acne



Leech therapy in Eczema Patient

(ii) Dermatological conditions: It has been described for psoriasis, vitiligo, alopecia, herpes zoster, and non-healing diabetic ulcers.

(iii) Glandular and ischemic conditions: Its use has also been reported in benign tumors, cysts, acute mastitis, and localized ischemic pain.



Leech therapy in Alopecia Patient

Therapeutic Workflow:

1. Pre-application: The area where the leech is to be applied is cleaned with sterile water. Soaps and chemical disinfectants are avoided because they may prevent the leech from attaching properly. The leeches are briefly soaked in a mustard-turmeric paste and then kept in fresh water for about 30 minutes.

2. Application: The leech is placed directly over the affected area. If it does not attach on its own, attachment can be encouraged using a small drop of milk or ghee, or by making a tiny puncture

to produce a small amount of blood. During feeding, the leech is kept moist with wet cotton. Each leech generally takes around 5 mL of blood.

3. Removal and post-care: The leech is usually allowed to detach naturally. If it needs to be removed earlier, rock salt (Saindhava) can be applied near its mouth. After removal, the bite site is treated with *Shatadhauta Ghrita* (Cow's ghee repeatedly washed with water 100 times transforming it into a soft, cooling preparation used traditionally for soothing and healing the skin) or turmeric powder. The used leech is dusted with rice flour and salt to promote regurgitation of the ingested blood. It is then washed with saline and turmeric water and kept separately for at least 7 days before being reused on the same patient.



4. Pharmacological Mechanisms of Leech Saliva

The therapeutic action of leech therapy is mainly related to the bioactive substances present in leech saliva. During feeding, leeches release more than 100 different biologically active molecules, which contribute to their effects on blood flow, clotting, and inflammation.

1. **Hirudin:** It directly acts against thrombin and helps prevent blood clot formation.
2. **Calin:** It interferes with the binding of von Willebrand factor to collagen, thereby reducing platelet aggregation.
3. **Destabilase:** It helps break down existing fibrin clots by showing fibrinolytic activity.
4. **Hyaluronidase:** It breaks down components of the extracellular matrix, which can increase tissue permeability and help the diffusion of antibiotics.
5. **Eglins and Bdellins:** These are serine protease inhibitors that help reduce inflammation by inhibiting enzymes such as trypsin, plasmin, elastase & cathepsin G.
6. **Histamine-like substances:** They act as vasodilators, increasing blood flow around the site where the leech is attached.

5. Ecological Threats, Institutional Preservation, and Sustainable Cultivation

Ecological Threats and Climate Impact:

Changes in the environment are affecting natural leech populations. Increasing air and water temperatures, irregular rainfall, industrial waste, loss of wetlands, and uncontrolled collection of leeches during their breeding period can reduce their numbers and disturb their natural habitats.

Institutional Preservation "*Jalauka* Banks" **-** To maintain a regular supply of healthy and disease-free medicinal leeches throughout the year, preservation centres and institutional "*Jalauka* Banks", including those established in Ayurvedic colleges in Patna and Begusarai, can follow standard maintenance practices:

- Keep the leeches in clean, chlorine-free water at a suitable temperature of around 15–25°C.
- Ensure proper aeration, protect them from direct sunlight, and change the water regularly.
- Avoid overcrowding and follow proper quarantine and screening procedures.

Sustainable Cultivation Models:

To reduce dependence on naturally occurring leech populations and help protect aquatic biodiversity, ex-situ cultivation and breeding methods can be developed.

- Artificial ponds: Earthen ponds of about 1–1.5 metres depth can be prepared and supplied with suitable native aquatic plants.
- Water quality monitoring: Water temperature can be maintained between 20–30°C, along with regular monitoring and control of pH and dissolved oxygen.
- Controlled breeding: Systems for collecting and incubating cocoons can be used to protect young leeches and improve their production

6. Conclusion

Jalaukavacharana has been used in Ayurveda for centuries and still has an important role in healthcare today. Its therapeutic benefits are now also being explored and supported through modern scientific studies. At the same time, the growing demand for medicinal leeches makes their proper conservation important. Protecting their natural habitats, maintaining *Jalauka Banks*, and developing safe breeding practices can help ensure that medicinal leeches remain available in the future. These efforts can support the continued practice of *Jalaukavacharana* while also helping to protect the natural freshwater environment in which leeches live.

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Black-crowned Night Heron, Eastern Cattle Egret, Asian Openbill, Black-headed Ibis, Little Cormorant

Waterbirds in Gaya Ji City: Population status and threats

Divya Kumari* and Ram Pratap Singh**

Urban green spaces have become ecological refuges for birds. These green spaces serve as valuable ecosystems and provide a range of services, including habitat for diverse fauna, mitigation of climate change impacts, shade, and reduced urban heat island effect. In recent years, increasing evidence has been reported of tree-nesting waterbirds using nesting and roosting sites across many Indian cities. These waterbirds forage in waterbodies in and around cities, breed and roost in crowded human-dominated areas including roadside trees, trees planted in and around government buildings, city ponds, and even near human settlements.

1. Colonial Nesting Waterbirds

Colonial nesting waterbirds such as storks, egrets, herons, ibises and cormorants tend to build their nests close to one another, forming single or multi-species colonies. Nest site selection is influenced by crucial factors, including predator avoidance, proximity to feeding grounds, human disturbance, climatic conditions, availability of nesting materials, and the quality of nesting trees, all of which affect reproductive success. They are widely known as indicators of ecosystem health and are sensitive to environmental changes. They provide valuable insights for monitoring ecosystem health, as they respond rapidly to environmental shifts, such as local wetland health and the quality of urban green spaces, by changing their abundance, distribution, and behaviours such as feeding and nesting. While urban areas provide suitable nesting space for these birds, it also exposes them to various anthropogenic pressures.

2. Waterbirds in Gaya Ji City

In Gaya Ji♦, many waterbird species were found nesting in anthropogenically modified areas of the city, underscoring the importance of these sites for nesting waterbirds. Thus, the current study aims to document the diversity and threats to colonial nesting waterbirds in the urban landscape of Gaya Ji, Bihar. The findings highlight both the adaptability of these birds to human-dominated landscapes and the need for site-based management to protect these populations. Beyond this, such colonies also offer an opportunity to support two current national plans: the National One Health Mission, which supports human, animal, and environmental health surveillance in cities, and the Nagar Van Yojna, which supports urban afforestation goals and enriches local biodiversity. ♦ New name of Gaya



Figure 1: Nesting waterbird species in Gaya Ji, Bihar

3. Study Area

The study was conducted in Gaya Ji (24°47’48.69" N and 85°0’13.86" E), Bihar, India. The nesting colony was spread over an area of approximately 0.24 km² in the core of the city, showing the compactness of the colony that holds thousands of birds. The locality features roads, government offices (including the District Collector's office, Commissioners' office, civil court, and revenue office), banks, residential buildings, towers, commercial

establishments, and ponds. The nesting site is heavily disturbed by traffic and frequent pedestrian activity. Still, the birds prefer nesting in these premises, highlighting the importance of this location for both people and wild birds. The waterbirds such as Asian Openbill (*Anastomus oscitans*), Black-crowned Night Heron (*Nycticorax nycticorax*), Eastern Cattle-Egret (*Ardea coromanda*), Black-headed Ibis (*Threskiornis melanocephalus*) and Little Cormorant (*Microcarbo niger*) were known to nest in the area.

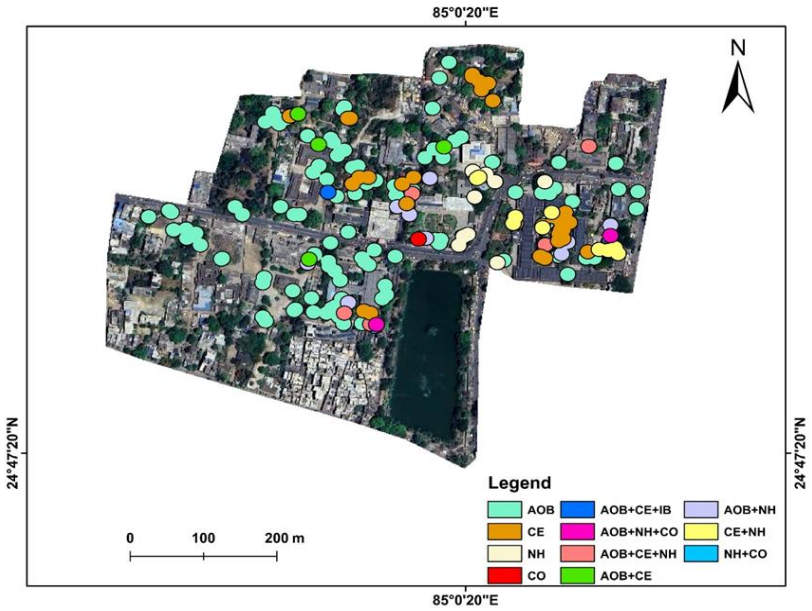


Figure 2: Study area showing trees with different colour dots of nesting waterbird species.

4. Field findings in Gaya Ji, Bihar

Breeding population of waterbirds in the city

The study focused on five waterbird species: Asian Openbill, Eastern Cattle Egret, Black-crowned Night Heron, Little Cormorant, and Black-headed Ibis. Nesting bird species were identified using a standard field guide, and the number of nests on each nesting tree was counted during the breeding season (July-September 2025) using the cold searching method. The number of nesting individuals per species ranged from 30 (Black-headed Ibis) to 3786 (Asian Openbill). Of the total number of species (n = 5058), the highest abundance was observed for the Asian Openbill, accounting for 74.8% of the total species population, followed by 16 % of Eastern Cattle Egret, 7.7% of Black-crowned Night Heron, 0.7% of Little Cormorant, and 0.6% of Black-headed Ibis. Nesting species represented 04 families. Species-wise data are presented in Table 1.

Table 1: Waterbird species participating in the heronries with number of nesting individuals.

Sr. no.	Species participating in the heronries	Family	Scientific name	No. of individuals
1	Asian Openbill	Ciconiidae	*Anastomus oscitans*	3786
2	Eastern Cattle Egret	Ardeidae	*Ardea coromanda*	814
3	Black-crowned Night Heron	Ardeidae	*Nycticorax nycticorax*	388
4	Little Cormorant	Phalacrocoracidae	*Microcarbo niger*	40
5	Black-headed Ibis	Threskiornithidae	*Threskiornis melanocephalus*	30

5. Tree species used by waterbirds

Nesting tree characteristics (tree species, height, canopy area, and girth at breast height) of the selected nesting trees were identified and measured. To determine the canopy area, radii were measured in four directions from the center of the nesting tree, and their average was taken. The circle's area was then used to estimate the canopy area. For tree height measurement, a range finder (Diamondback HD 2000 Laser Rangefinder) was used, and the height was measured using the Sine method. GBH was measured with a tape measure at 1.37 m above the ground. The result showed a total of 27 tree species were used by these waterbird species within the study area. Among these, Peepal (*Ficus religiosa*), Neem (*Azadirachta indica*), and Cluster fig (*Ficus racemosa*) were the most commonly used tree species, accounting for 22.5%, 14.3%, and 8.5% of total observed nests (n = 2529), respectively. Other tree species supporting nests included Bel or Wood Apple (*Aegle marmelos*), Imli (*Tamarindus indica*), Kapok (*Ceiba pentandra*), Jamun (*Syzygium cumini*), Kadamb (*Neolamarckia cadamba*), Yellow Gulmohar (*Peltophorum pterocarpum*), Sapt parni or Scholar tree (*Alstonia scholaris*), Gulmohar (*Delonix regia*), False Ashoka (*Polyalthia longifolia*), Mango (*Mangifera indica*), Banyan (*Ficus benghalensis*), Shisham (*Dalbergia sissoo*), Amaltas (*Cassia fistula*), Kasod (*Senna siamea*), Moringa (*Moringa oleifera*), White Champa (*Plumeria alba*), Madras Thorn (*Pithecellobium dulce*), Pakar (*Ficus virens*), Gamhar (*Gmelina arborea*), Arjuna (*Terminalia arjuna*), Indian Mahogany (*Swietenia mahagoni*) Rain tree (*Samanea saman*), Eucalyptus (*Eucalyptus camaldulensis*) and Sagwan (*Tectona grandis*). Nest distribution varied, with Asian Openbill nests predominantly abundant within the studied species.

6. Tree architecture and nesting height of the species

These waterbirds utilise a diverse range of native and exotic tree species for nesting. The tree architecture of the preferred nesting trees is shown in Table 2. Several old and tall trees favoured for nesting activities were of Ficus species, including *Ficus religiosa, Ficus benghalensis, Ficus virens* and *Ficus racemosa*, which accounted for 15% of the total nesting tree species. Ficus tree species were maintained throughout the city despite their large size, owing to religious beliefs. These waterbird species nest at different average heights, ranging from 7.5 to 12.7 meters. Among the recorded species, the Little Cormorant had the highest nest height, followed by the Black-crowned Night Heron, Asian Openbill, Black-headed Ibis and Eastern Cattle Egret (Table 3)

Table 2: Average tree height, girth at breast height (GBH), and canopy area of nesting trees.

Species	Height (m±sd)	GBH (m±sd)	Canopy (m±sd)
Asian Openbill	11.1 ± 2.4	2.2 ± 1.3	156.7 ± 111.6
Little Cormorant	13.3 ± 1	2.3 ± 1.2	172.1 ± 123.2
Eastern Cattle Egret	9.2 ± 1.8	1.4 ± 0.9	106.4 ± 75.4
Black-crowned Night Heron	11.5 ± 2.4	2.2 ± 1.3	164 ± 140.8
Black-headed Ibis	12.3	2.0	215.9

Table 3: Average tree height in relation to average nest height used by nesting waterbirds

Species	Average Nest Height (m±sd)	Relative Nest Height
Asian Openbill	9.7±2.03	0.87
Black- crowned Night Heron	10.9±2	0.94
Eastern Cattle Egret	7.5±1.6	0.82
Little Cormorant	12.7±2.6	0.95
Black-headed ibis	8.2±0.2	0.67

7. Threats to nesting waterbirds at Gaya Ji, Bihar

Cutting of nest trees or damage to canopies

The present study documented three tree canopy cutting incidents which resulted in the loss of 38 active nests of bird species (28 nests of Asian Openbill, 6 nests of Eastern Cattle Egret and 4 nests of Black-crowned Night Heron). Most nests contained chicks and eggs (Figure 3).

Collision with building walls

Birds suffer internal haemorrhages, damage to eyes, skull or instant death. We found three cases of collision with buildings (Figure 3).

Construction near nesting sites

Construction activity was observed near nesting sites in areas surrounding Jila Parishad, Collectorate building, and Prabhavati Hospital (Figure 3).

Entanglement with mesh threads

Birds often become entangled in mesh threads; as a result, these birds remain suspended from trees, sometimes unnoticed until they are either rescued by people or succumb to their injuries and die. In this study period, we found seven cases of entanglement with mesh thread (Figure 3).

Regurgitated food samples of waterbirds contain rubber bands

Of the 65 regurgitated pellets collected from the study area, 11 contained rubber bands with different colours (pink, red, yellow and green). These constitute 17% of the total collected sample. The frequency of the coloured bands was pink (30.7%), yellow (46.1%), green (7.6%) and red (15.8%)



Figure 3: Different types of threats observed at the nesting site.

8. Conservation and Recommendations

1. Protection of Habitat using Nature-Based Solutions

(i) To protect old native trees, especially Banyan, Peepal, Mango, and other large Ficus species, which provide a large canopy area for nesting of these waterbirds.

(ii) Avoid felling or heavy pruning of trees before and during the breeding season (May – October).

2. Urban planning and management

(i) Encouraging a bird-friendly city layout with buildings and premises locations considering the bird habitats in existing city limits and in the expansion zones.

(ii) Maintenance of green spaces and water bodies in the city.

(iii) Regulation of unavoidable constructions and processes related thereto so as to minimise threats to the colonising birds.

(iv) Factoring connectivity between natural features e.g. canopies in development of urban grey infrastructure – buildings and roads etc.

(v) Implementing practical measures adapted to cope with any environmental disservices - real or perceived related to profuse droppings of the nesting birds.

3. Restore wetlands and water bodies within and around the Gaya Ji urban areas for supporting biodiversity.

4. Systematic monitoring

(i) Long term monitoring of nesting bird population in urban areas and consider linking it with the state-level **wildlife disease surveillance network**.

(ii) Continuous monitoring will help understand the **population dynamics** of nesting waterbirds, as continued urbanisation poses a substantial threat to the long-term viability of such colonies.

5. Increasing public awareness to reduce *bird-human conflict*

Engage local residents like Kokkare Bellur, one of the sites in Karnataka. This is one of the oldest known pelicanry in Karnataka. It is a traditional nesting site of Spot-billed Pelicans (*Pelecanus Philippensis*) and Painted Storks (*Mycteria leucocephala).* These have been protected by villagers themselves. Shooting of birds or collection of eggs in the village is strictly prohibited. Here we can also form the voluntary **Pakshi Mitras**, who will safeguard these important nesting waterbirds of Gaya Ji city and lead the community conservation programme and foster **Citizen Science** movement.

6. Responsible disposal of rubber bands and Manjha (kite thread).

1. Bird Rehabilitation Centre

For sustained conservation action, a bird rehabilitation centre to be set up in Gaya Ji by the State Forest Department will enhance protection of these waterbirds, as many small chicks and juveniles fall from the nest, leading to injury or attacked by predators.

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भृंग – प्रकृति के सूक्ष्म प्रबंधक

जंगलों, खेतों, नदियों और आर्द्रभूमियों में चुपचाप काम करते हैं प्रकृति के ये छोटे इंजीनियर

भावेश कुमार*

एक पल के लिए अपने आसपास की प्रकृति को ध्यान से देखिए। पेड़ की छाल पर रेंगता एक छोटा–सा भृंग, मिट्टी में दबा कोई सूक्ष्म जीव या गोबर के पास तेजी से चलता एक छोटा कीट शायद हमारी नजर में महत्वहीन हो। लेकिन यही छोटे जीव प्रकृति की उन प्रक्रियाओं को लगातार संचालित कर रहे हैं, जिन पर जंगल, खेत, आर्द्रभूमि और अंततः हमारा जीवन निर्भर करता है।

बिहार की जैव विविधता की चर्चा होते ही गंगा, कोसी और गंडक जैसी नदियाँ, आर्द्रभूमियाँ, वन क्षेत्र और पक्षी–वन्यजीव हमारे ध्यान में आते हैं। लेकिन इस दिखाई देने वाली प्रकृति के पीछे असंख्य छोटे जीव लगातार ऐसे कार्य कर रहे हैं, जिनके बिना पारिस्थितिक तंत्र सुचारु रूप से काम नहीं कर सकते हैं।

बिहार की गंगा के किनारे से लेकर कोसी के बाढ़ मैदानों तक, खेतों की मेड़ों से लेकर जंगलों की पत्तियों के नीचे और बराबर–राजगीर एवं कैमूर पठारी की चट्टानी दरारों से लेकर शहरों के छोटे–छोटे उद्यानों तक भृंगों की एक अदृश्य दुनिया लगातार सक्रिय रहती है। ये छोटे जीव मृत पत्तियों और लकड़ी को तोड़ते हैं, गोबर को मिट्टी में मिलाते हैं, दूसरे कीटों की आबादी नियंत्रित करते हैं, पोषक तत्वों का पुनर्चक्रण करते हैं और स्वयं पक्षियों, उभयचरों तथा सरीसृपों के भोजन का हिस्सा बनते हैं। प्रकृति का यह काम इतना सहज और निरंतर है कि हम अक्सर इसे देख ही नहीं पाते।

भृंग कोलियोप्टेरा (Coleopter) गण के सदस्य हैं और पृथ्वी के सबसे विविध जीव समूहों में शामिल हैं। इनकी विभिन्न प्रजातियाँ अलग–अलग आवासों और भोजन स्रोतों के अनुरूप विकसित हुई हैं। बिहार में इनके लिए वन, कृषि क्षेत्र, नदी तट, आर्द्रभूमि, घासभूमि, चट्टानी क्षेत्र और शहरी हरित क्षेत्र जैसे अनेक आवास उपलब्ध हैं।

इसी अनदेखी जैव विविधता को सामने लाने के लिए बिहार राज्य जैव विविधता पर्षद ने राज्य में बीटल की विविधता, वितरण और पारिस्थितिक भूमिका के वैज्ञानिक अध्ययन एवं दस्तावेजीकरण की पहल की है अध्ययन के दौरान विभिन्न आवासों से बीटल की तस्वीरें, पहचान, आवास एवं वितरण संबंधी जानकारी संकलित की जा रही है। जिससे बिहार की बीटल विविधता का एक प्रारंभिक वैज्ञानिक डेटाबेस विकसित करने में मदद मिलेगी।

इस अध्ययन का उद्देश्य बिहार की कम–अध्ययनित कीट जैव विविधता के संबंध में आधारभूत जानकारी विकसित करना है।

अध्ययन के प्रथम चरण में विभिन्न प्रकार के पर्यावासों को शामिल किया गया है, जिनमें पटना के शहरी क्षेत्र में स्थित विभिन्न पार्क, रोहतास–कैमूर पठारी क्षेत्र, आर्द्रभूमियाँ तथा कृषि भूमि सम्मिलित हैं। इन भिन्न–भिन्न पर्यावासों का चयन इसलिए महत्वपूर्ण है क्योंकि इनके वनस्पति स्वरूप, मृदा, नमी, जल उपलब्धता और मानवीय गतिविधियों में पर्याप्त अंतर पाया जाता है, जो बीटल समुदायों की संरचना एवं वितरण को प्रभावित कर करते हैं।

विभिन्न प्रकार के पर्यावासों

S.No.	Landscape	Site Name
1	Agricultural Area	Agriculture area of Punpun and Ganga belt, Fatua Bariya Bus stand.
2	Urban Agglomerate	Collectorate Ghat, Antaghat, Collectorate Ghat, Danapur
3	Park	Rajdhani Vatika and Shaheed Veer Kunwar Singh Azadi Park
4	Wetland	Kalyanpur ash dyke, Motipur mann, Dumari lake, Sikandarpur Lake, Baniyarahi chaur in Muzaffarpur District.
5	Riparian Area	Punpun and Ganga Marine drive Digha.
6	Forest and Rock outcrops	Dhankada and Kanjiyari Hill Sasaram.

अध्ययन के अंतर्गत फील्ड सर्वेक्षण, फोटोग्राफिक दस्तावेजीकरण, आवास संबंधी जानकारी, प्रजातीय पहचान तथा आवश्यकतानुसार विशेषज्ञ सत्यापन के माध्यम से डेटा संकलित किया जा रहा है। प्राप्त जानकारी से बिहार में बीटल विविधता का प्रारंभिक डेटाबेस विकसित करने तथा विभिन्न पर्यावासों में इनके पारिस्थितिक महत्व को समझने में सहायता मिलेगी।

इस अध्ययन का एक महत्वपूर्ण पक्ष यह भी है कि आम नागरिक और स्थानीय समुदाय अपने आसपास मौजूद जैव विविधता को पहचानने और समझने में भागीदार बन सके। किसी बगीचे, खेत या पेड़ के आसपास दिखाई देने वाला छोटा–सा बीटल भी वैज्ञानिक दस्तावेजीकरण के लिए उपयोगी रिकॉर्ड बन सकता है। भृंगों का अध्ययन केवल प्रजातियों की संख्या जानने के लिए नहीं, बल्कि पारिस्थितिक तंत्र के कार्यों को समझने के लिए भी महत्वपूर्ण है। अपघटक, परभक्षी, मृदा–आधारित और जलीय भृंगों की उपस्थिति किसी क्षेत्र की पर्यावरणीय स्थिति के बारे में उपयोगी संकेत दे सकती है। इस प्रयोजनार्थ पर्षद द्वारा प्रशिक्षु (Internship) योजना के अंतर्गत, प्रशिक्षु के माध्यम से सर्वेक्षण एवं अध्ययन कार्य को सम्पादित किया जा रहा है।

1. भृंगों की विभिन्न पारिस्थितिक तंत्र में महत्वपूर्ण भूमिका

भृंगों की सबसे महत्वपूर्ण भूमिकाओं में से एक है जैविक पदार्थों का विघटन और पोषक तत्वों का पुनर्चक्रण। जंगल में गिरने वाली पत्तियाँ, सूखी लकड़ियाँ, मृत जीव और पशुओं का गोबर प्रकृति में बेकार नहीं जाते। विभिन्न अपघटक जीव इन्हें धीरे–धीरे विघटित करके पोषक तत्वों को फिर मिट्टी में वापस पहुँचाते हैं। इस महत्वपूर्ण जैविक परिस्थित चक्र को सम्पादित करते हुए भी इन छोटे जीवों को संकटों एवं चुनौतियों का सामना करना पर रहा है, जिससे उनके उत्तर जीविता संकट में हैं। जैसे – आवासों का विनाश, अत्यधिक कीटनाशक उपयोग, आर्द्रभूमियों का क्षरण, प्रदूषण और अनियोजित शहरीकरण इन छोटे जीवों के आवास को प्रभावित कर सकते हैं। समस्या यह है कि किसी भृंग की संख्या घटने पर उसका प्रभाव तुरंत दिखाई नहीं देता, लेकिन लंबे समय में इससे पोषक चक्र, खाद्य–जाल और प्राकृतिक कीट नियंत्रण जैसी प्रक्रियाएँ प्रभावित हो सकती हैं।

गोबर भृंग इसका शानदार उदाहरण हैं। वे पशुओं के गोबर को एकत्र कर मिट्टी में दबाते हैं। इससे जैविक पदार्थ मिट्टी में पहुँचता है और पोषक तत्वों के पुनर्चक्रण में मदद मिलती है। इस प्रक्रिया से मिट्टी की जैविक गुणवत्ता और सूक्ष्मजीवी गतिविधि को भी लाभ मिल सकता है।

अर्थात्, कुछ मिलीमीटर या कुछ सेंटीमीटर का एक जीव खेत और चरागाह के पोषक चक्र में महत्वपूर्ण योगदान दे सकता है।

2. भृंगों की कृषि–क्षेत्र में महत्वपूर्ण भूमिका

बिहार की कृषि भूमि में भृंगों की एक अन्य महत्वपूर्ण भूमिका दिखाई देती है। लेडीबर्ड और ग्राउंड बीटल जैसे कई भृंग अन्य छोटे कीटों का शिकार करते हैं। वे खेतों में कीट आबादी को प्राकृतिक रूप से नियंत्रित करने वाली खाद्य श्रृंखला का हिस्सा हैं।

इसलिए खेतों की मेड़ों, झाड़ियों और प्राकृतिक वनस्पति को बनाए रखना केवल पौधों की विविधता के लिए नहीं, बल्कि लाभकारी कीटों के संरक्षण के लिए भी महत्वपूर्ण है। कृषि क्षेत्र में महत्व को देखते हुए पटना, पुनपुन, फतुआ के आसपास के कृषि बाहुल्य क्षेत्रों में भृंगों की त्वरित सर्वेक्षण कराया गया।

यह समझना आवश्यक है कि कृषि में हर कीट शत्रु नहीं होता। कुछ कीट स्वयं फसल को नुकसान पहुँचा सकते हैं, जबकि कुछ दूसरे कीटों को नियंत्रित कर किसान के सहयोगी बनते हैं।

अध्ययन के दौरान कृषि क्षेत्रों में पाए जाने वाले भृंग (Beetles)


Scarites terricola


Pheropsophus sobrinus


Calosoma maderae


Catharsius pithecius


Chlaenius pictus


Harpalus rubripes


Chlaenius sericeus


Gymnopleurus miliaris


Cicindela bicolor


Cicindela flavomaculata


Paederus fuscipes


Onthophagus taurus


Hycleus phaleratus


Hycleus biundulatus


Diapromorpha pallens


Olenecamptus bilobus

3. भृंगों की आद्रभूमियों एवं नदी तंत्र में भूमिका

बिहार की आर्द्रभूमियाँ केवल पक्षियों के लिए ही महत्वपूर्ण नहीं हैं। इनके पानी, कीचड़, वनस्पति और आसपास के क्षेत्र में अनेक अकशेरुकी (Invertebrates) जीव रहते हैं। जलीय भृंग इन पारिस्थितिक तंत्रों के खाद्य–जाल का हिस्सा हो सकते हैं और कुछ प्रजातियाँ परभक्षी अथवा जैविक पदार्थों के उपभोक्ता के रूप में कार्य करती हैं।

इसी तरह गंगा, गंडक, कोसी और सोन जैसी नदियों की जैव विविधता केवल मुख्य नदी चैनल तक सीमित नहीं है। नदी तट, बालू क्षेत्र, बाढ़मैदान और आसपास की आर्द्रभूमियाँ मिलकर एक विस्तृत नदीय पारिस्थितिकी तंत्र बनाती हैं, जो विभिन्न प्रकार के छोटे जीवों का अधिवास क्षेत्र भी है। इन पारिस्थितिक महत्व को देखते हुए राज्य के कुछेक क्षेत्र के उपग्रह चित्र, GIS आंकड़े एवं क्षेत्रीय सर्वेक्षणों को एकीकृत कर राज्य में विभिन्न आद्रभूमि एवं नदी क्षेत्र विशेषकर पूर्वी चंपारण, मुजफ्फरपुर के आद्रभूमि गंगा एवं पुनपुन के नदी पारितंत्र का अध्ययन सम्मिलित है।

आद्रभूमि एवं नदी तंत्र में पाए गए भृंग (Bettles)

Family	Scientific Name
Dytiscidae	*Cybister spp.* (Curtis, 1827)
Hydrophilidae	*Hydrophilus spp.* (Geoffroy, 1762)



Subgenus Cybister



Subgenus Hydrophilus

4. वन और चट्टानी क्षेत्रों के छोटे इंजीनियर

बिहार के वन क्षेत्रों में पत्तियों की मोटी परत, मृत लकड़ी और सड़ती वनस्पति भृंगों तथा अन्य अपघटकों के लिए महत्वपूर्ण संसाधन हैं। वहीं राजगीर, बराबर, मुंगेर एवं दक्षिणी बिहार के पठारी भू–भाग जैसे चट्टानी परिदृश्य छोटे–छोटे विशिष्ट आवास बनाते हैं, जहाँ दरारें, मिट्टी और मौसमी वनस्पति अनेक सूक्ष्म जीवों को आश्रय प्रदान करते हैं। इसलिए ऐसे क्षेत्रों का संरक्षण केवल बड़े वन्यजीवों या वनस्पतियों के लिए नहीं, बल्कि उनकी सूक्ष्म जैव विविधता के लिए भी आवश्यक है इसलिए इन क्षेत्रों की जैव विविधता को समझते समय केवल वृक्षों और बड़े जीवों पर ध्यान देना पर्याप्त नहीं होगा।

वन एवं चट्टानों क्षेत्रों में पाए गए भृंग



Cicindela bicolor



Gymnoplurus cyaneus



Sisyphus longipes



Anthelephila caeruleipennis



Clinteria klugi



Gymnopleurus humeralis



Scarabaeus sacer



Aulacophora lewisii



Lycostomus spp.



Intybia korshunovi



Calligrapha bicolorata



Neocleonus spp.

बिहार में चयनित **शहरी उद्यानों, वन क्षेत्रों, पथरीले एवं शैल– शैल दृश्यांश क्षेत्रों, आर्द्रभूमियों तथा कृषि – परिदृश्यों** में किए जा रहे जैव विविधता अध्ययन के दौरान कुल – **18 कुल के 171 भृंगों** की उपस्थिति दर्ज किया गया है जिसकी आवास–सम्बद्धता तथा पारिस्थितिक भूमिका निम्न है ।

S.N.	Order	Major group/family	Common Name	No. of species	Common ecological role	Typical habitats surveyed
1	*Coleoptera*	*Gyrinidae*	Whirligig beetles	1	Predators and scavengers at the water surface	Ponds, pools, slow-moving streams
2		*Dytiscidae*	Predaceous diving beetles	1	Aquatic predators	Ponds, pools, seasonal water bodies
3		*Carabidae*	Ground beetles	17	Predators of insects and other small invertebrates	Soil, leaf litter, rocky ground, grassland
4		*Hydrophilidae*	Water scavenger beetles	1	Scavenging and feeding on organic matter, some are predators	Ponds, seasonal pools, waterlogged areas
5		*Staphylinidae*	Rove beetles	5	Predators, scavengers, and decomposers	Leaf litter, soil, dung, decaying organic matter
6		*Scarabaeidae*	Scarab and dung beetles	15	Dung decomposition, nutrient cycling, soil aeration	Dung patches, grassland, soil, leaf litter
7		*Lycidae*	Net-winged beetles	1	Adults often visit flowers, larvae may be predators or feed on decaying wood	Vegetation, forest edges, deadwood
8		*Melyridae*	Soft-winged flower beetles	1	Predation on small insects; some adults feed on pollen	Flowers, grasses, shrubs
9		*Coccinellidae*	Ladybird beetles	31	Predators of aphids and other small insects	Crops, shrubs, grasses, flowering plants
10		*Anthicidae*	Ant-like flower beetles	3	Feed on small invertebrates, fungi, and plant material, depending on species	Leaf litter, dry vegetation, soil surface

11		*Meloidae*	Blister beetles	3	Adults often feed on flowers or foliage; larvae have varied lifestyles	Flowering plants, grassland, scrub
12		*Tenebrionidae*	Darkling beetles	3	Decomposition and detrital food webs	Dry soil, rocks, deadwood, leaf litter
13		*Buprestidae*	Jewel beetles	1	Larvae commonly develop in wood or plant tissues	Tree trunks, deadwood, woody vegetation
14		*Attelabidae*	Leaf-rolling weevils	4	Leaf-rolling and plant-feeding, some larvae develop in rolled leaves	Shrubs, trees, foliage
15		*Brentidae*	Straight-snouted weevils	2	Mainly plant-associated, larvae often develop in plant tissues or wood	Tree bark, deadwood, stems
16		*Curculionidae*	True weevils	18	Plant feeders, some species are seed or root feeders	Vegetation, stems, seeds, soil
17		*Cerambycidae*	Longhorn beetles	7	Larvae bore into wood or stems, contribute to decomposition	Deadwood, tree trunks, branches
18		*Chrysomelidae*	Leaf beetles	53	Herbivores feeding on leaves and other plant parts	Grasses, shrubs, crops, trees
19		*Cicindelidae*	Tiger beetles	4	Predators of small insects	Exposed soil, sandy trails, rocky ground
Total no of Species				**171**		

यह पहल बिहार की सूक्ष्म एवं अक्सर अनदेखी जैव विविधता को वैज्ञानिक रूप से दर्ज करने की दिशा में एक महत्वपूर्ण प्रारंभिक प्रयास है। एवं अध्ययन से प्राप्त जानकारी भविष्य में जैव विविधता संरक्षण, पारिस्थितिक निगरानी, शोध और पर्यावास प्रबंधन के लिए आधार वन सकती है।

''भृंग छोटे जरूर है, लेकिन प्रकृति के संचालन में उनकी भूमिका बहुत बड़ी है।'' यही कारण है कि इन्हें प्रकृति के ''सूक्ष्म प्रबंधक'' कहना अतिशयोक्ति नहीं, बल्कि पारिस्थितिकी की एक महत्वपूर्ण सच्चाई है।

Information and Photos of beetles are provided by Sunanda Kumari (Intern BSBB).

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कृषि जैव विविधता संसाधन से संबंधित पहुँच और लाभ साझाकरण व्यवस्था – बिहार के समुदायों के लिए प्राप्त हिस्सेदारी : कुछ तथ्य, कुछ आंकड़े

मोईनउद्दीन अंसारी*

जैव विविधता सम्बन्धी नीति और कानून का एक महत्वपूर्ण पहलु यह है कि जैविक संसाधनों के उपयोग में स्थानीय समुदाय, जिनके क्षेत्र से इनकी प्राप्ति होती है, इनसे होने वाले फायदे में उन्हें समुचित हिस्सेदारी मिले।

जैव विविधता के संबंध में अन्तर्राष्ट्रीय समझौते (Convention on Biological Diversity-CBD) में इस पहलु को एक मौलिक सिद्धान्त के तहत मान्यता दी गयी है। जैव विविधता संरक्षण संबंधी संवाद में इसे Fair and equitable sharing of benefits arising out of use of biological resources से जाना जाता है। इसकी व्यावहारिक कार्य–व्यवस्था Access Benefits Sharing (ABS) Mechanism के नाम से प्रचलित है।

हमारे देश में जैव विविधता अधिनियम, 2002 के अन्तर्गत इसके लिये नियम बनाये गये हैं। इस कानून के प्रभावी क्रियान्वयन के लिये राष्ट्रीय जैव विविधता प्राधिकरण तथा सभी राज्यों के जैव विविधता पर्षद् प्रयासरत हैं।

इनके अन्तर्गत कृषि एवं अनुषांगी जैविक संसाधनों को उनके विशेष गुण/लक्षण के लिए निर्यात अथवा देश में विशेष वाणिज्यिक प्रयोजनों से अनुसन्धान के उपयोग से सम्बद्ध मामलों में औद्योगिक या वाणिज्यिक फर्मों को होने वाले फायदे से साझेदारी बांटने के लिए नियम बनाये गये हैं। ऐसे फर्मों/कम्पनी से राष्ट्रीय जैव विविधता प्राधिकरण द्वारा एक नियत अनुपात में शुल्क अथवा लाभ की राशि वसूली जाती है। इन वसूली गयी राशियों को स्थानीय जैव विविधता प्रबन्धन समितियों के उपयोग हेतु राज्यों को हस्तांतरित की जाती है।

Access Benefits Sharing (ABS) कार्य–व्यवस्था के अन्तर्गत राष्ट्रीय जैव विविधता प्राधिकरण द्वारा फर्मों से प्राप्त राशि का संबंधित राज्यों को हस्तांतरित करने की प्रक्रिया हाल में शुरू की गयी है। अबतक ₹ 278 करोड़ की राशि विभिन्न वानिकी, कृषि एवं पुशपालन के जैविक उत्पादों के वाणिज्यिक उपयोग हेतु फर्मो, जिनमें विदेशों में निर्यात अथवा कॉमर्शियल रिसर्च के मामले भी सम्बद्ध हैं, ABS की सकल प्राप्त है। राष्ट्रीय जैव विविधता प्राधिकरण द्वारा इस वसूली गयी ABS की जमा राशि ₹ 278 करोड़ में से विगत महीनों में कुल ₹ 200 करोड़ विभिन्न राज्यों को हस्तांतरित की गयी हैं। इनमें से बिहार राज्य को ₹ 205.27 लाख की राशि जुलाई, अगस्त और सितम्बर 2026 की अवधि में हस्तांतरित हुई है। यह राशि निम्नांकित कृषि जैव विविधता के 13 उत्पादों से संबंधित है:–

सब्जी – **9** – खीरा, तरबूज, फूलगोभी, भिण्डी, बैंगन, प्याज, टमाटर, करेला, कद्दू
मसाले – मिर्च एवं काली मिर्च,
तेलहन – सरसों,
अनाज– चावल

इन कृषि उत्पादों को उनके विशेष लक्षणों के लिए निर्यात् /उत्पादन हेतु अथवा उन्हें वैसे अनुसन्धान के लिए उपयोग किया गया है, जिनसे भविष्य में वाणिज्यिक लाभ की अपेक्षा है।

इनसे संबंधित फर्म निम्नांकित है:–

1. Bayer Science & Innovation Ltd.
2. Pioneer Overseas Corporation
3. HM Clause India Pvt.
4. Advanta Enterprises Ltd.
5. Nunhems India Pvt. Ltd.
6. East West Seeds India Pvt. Ltd.

इन 6 फर्मों/कम्पनियों से ये राशियाँ विभिन्न चरणों में प्राप्त हुई हैं, जो वाणिज्यिक उपयोग (निर्यात सहित) अथवा वाणिज्यिक अनुसन्धान अनुप्रयोग के मामलों में राष्ट्रीय जैव विविधता प्राधिकरण को विगत कुछ वर्षों में प्राप्त हुई हैं।

ACCESS-BENEFIT-SHARING Fund Received by Bihar from National Biodiversity Authority, Jul-Sep 2026

Sl. No.	Biological Resource	Purpose	Firm Name	Amount (Rs. in Lakh)
1	Rice hybrids	Commercial Utilization	Pioneer Overseas Corporation	36.93
2	Watermelon	Research	Bayer Science & Innovation Pvt. Ltd.	4.48
		Research & Commercial Utilization	HM Clause India Pvt. Ltd.	
3	Bitter Gourd - 4 var., Bottle Gourd - 91 var., Brinjal - 2093 var., Cauliflower - 18 var., Hot Pepper - 217 var., Okra - 103 var., Tomato - 294 var.	Research & Commercial Utilization	Advanta Enterprises Ltd.	123.64

4	Chilli	Research	Bayer Science & Innovation Pvt. Ltd.	17.04
		Research & Commercial Utilization	HM Clause India Pvt. Ltd.	
5	Mustard - 10 hybrids	Commercial Utilization	Pioneer Overseas Corporation	15.04
6	Cucumber	Research	Bayer Science & Innovation Pvt. Ltd.	3.55
		Research	East West Seeds India Pvt. Ltd.	
		Research /Commercial Utilization	Nunhems India Pvt. Ltd.	
7	Onion	Research /Commercial Utilization	East West Seeds India Pvt. Ltd.	4.59
		Research	Bayer Science & Innovation Pvt. Ltd.	
13 Agriculture Species - 9 Vegetable (Bitter Gourd, Bottle Gourd, Brinjal, Cauliflower, Chilli, Cucumber, Okra, Tomato, Watermelon); Spices (Chilli and Hot Pepper); Cereal - Rice, Oilseed: Mustard			**6 Firms:** Advanta, Bayer, East West Seeds, Pioneer Overseas, Nunhens India, HM Clause India**.**	**205.27**

ABS की जमा राशि में राज्यों के हिस्सों का आकलन

इनमें अधिकांश मामलों में फर्मों द्वारा उक्त 13 कृषि जैविक उत्पादों को देश के कृषकों, कृषि बाजारों एवं व्यापारियों से इत्यादि से क्रय किया गया है, एवं इनके स्त्रोत स्थलों की विनिर्दिष्ट अथवा सही–सही जानकारी अभिलेखित नहीं रही है अथवा उनके स्त्रोत क्षेत्रों को अलग–अलग पहचान करना सम्भव नहीं हो पाया है। ऐसी परिस्थिति में राष्ट्रीय जैव विविधता प्राधिकरण द्वारा इनके स्त्रोत क्षेत्रों/स्थानों को unidentified की श्रेणी में रखा गया है। ऐसे मामलों के लिये राज्यों की हिस्सेदारी तय करने के लिये विशेष व्यवस्था की गयी। राष्ट्रीय जैव विविधता प्राधिकरण ने पाया कि प्रश्नगत सभी 13 कृषि जैविक संसाधन देश के 10 से अधिक राज्यों के कृषि उत्पादन में सम्मिलित हैं। अतएव प्रत्येक प्रासंगिक जैविक कृषि उत्पाद राज्यों में कितने–कितने क्षेत्रफल में खेती किये जाते हैं, इसके सम्बन्ध में केन्द्र सरकार के कृषि मंत्रालय के सांख्यिकी आंकड़ों का उपयोग कर क्षेत्रफल के अनुपात में राज्यों के बीच संचयित राशियों का अधिकांश प्रतिशत (70% से 95% प्रतिशत) हस्तांतरित किया गया है।

Access-Benefit Sharing के अन्तर्गत प्राप्त राशि का उपयोग – ABS की इन राशि का उपयोग पंचायतों की जैव विविधता प्रबन्धन समितियों को सक्रिय और सक्षम बनाने के लिए विभिन्न क्रिया–कलापों द्वारा किया जाना है।

आशा है कि Access-Benefit Sharing Mechanism के अन्तर्गत इस प्रकार की Benefit Sharing की प्रक्रिया जारी रहेगी, एवं इसमें अपेक्षित वृद्धि होगी।
इसके लिये कृषक समुदाय, कृषि–व्यापारी, कृषि उद्योग, कृषि उत्पादों के निर्यातकर्ता एवं अन्य हितधारकों (स्टेकहोल्डर्स) का सक्रिय सहयोग एवं सहभागिता वांछित है।

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*लेखा पदाधिकारी, बिहार राज्य जैव विविधता पर्षद्।



Memories of a Pachycaul

Harshita Prakash*

I joined St. Michael's High School in 2000 as a wide eyed 7 year old and remember being so fascinated by its gothic architecture, the flared wooden staircase, the bridges connecting two buildings, the beautiful library but I remember being just as fascinated by the greenery especially the tall trees inside the campus. The verdant campus was my only way to see and learn about different species of plants and by class 7th, I knew the names of most of the trees with the help of websites like Flowers of India or going home with whatever details I could remember and search on the internet. It was in this class 7th of mine that we were taken for a field trip to Taru Mitra Ashram, where we learnt that the first two trees with a thick trunk (pachycaul) that greet you first when you enter the St.Michael's campus are in fact called African Baobabs, also known as Kalptaru/ Khursani Imli*. They told us about the year and how it had been gifted to the campus. Since almost two decades have passed since that day and I never wrote anything in my notebook I do not remember the clear details but the next few days of mine were spent making everyone I knew aware about these two Baobab trees on campus.

I left Patna in 2009 for Ranchi for higher studies and found out that the city also had three African Baobab trees near the reputed Doranda College and how there had been an uproar when people had tried to use the tree to pin flex boards on the trunk harming them, as they were a heritage for the state.

As time passed I kept coming across multiple articles on African Baobabs in India, the

theories on how it must have arrived in India and its status across the country. There are about 1000 individuals of African Baobabs preserved by the Bhil tribe scattered across the town of Mandu in Madhya Pradesh, probably the highest in India, followed by Maharashtra which has some 400 individuals which are documented through various social media pages. Upon searching on the internet through multiple literature many more African Baobabs were found across the country some in large numbers while some states or cities had a handful of them but there was a common reverence for this species everywhere.

Ecological Significance

African Baobabs as the name suggests are native to the continent of Africa and southern Arabian Peninsula , belonging to the Malvaceae family. These trees are iconic because of the images they evoke to the observer, towering trees in vast open grasslands and thorn scrub. The ones in India seem nothing like the African Baobabs one would encounter in their native land, statuesque with a smooth trunk, the radiating crown while the ones we see here are gnarly, not that imposingly tall but remind of small elephants probably why they are called "Haathiya Jhaad" in some states.

All Baobabs occur in dry , arid areas and shed their leaves during the dry season. They are well known to store gallons of water in the trunk to endure harsh drought conditions. The wide tree trunk also acts as nesting sites for many cavity nesting birds like Owls and Starlings.





African Baobab as a Heritage Tree for Bihar

The history of the arrival of the African Baobab in India dates back to the 18th -19th Century which makes all the existing Baobab Trees in India more than a 100 years old and a very strong contender for the tag of a Heritage Tree. Baobab trees are considered as a heritage in many Indian states, the fruit of the Baobab is sold in Mandu as Khorasani Imli, a fruit potent in Vitamin C. In Shirla, Maharashtra, few of these trees stand near Bhuikot Fort surrounded by raised platforms and are respected because they are thought to be planted during the rule of Chhatrapati Shivaji.

The African Baobabs in Patna lack documentation when compared to other states , the only two known individuals exist in the campus of St. Michael's High School which was founded in 1858, as the second oldest school of Bihar now in itself is a heritage for the state. The Heritage Tree scheme of Bihar identifies trees which are over 75 years of age, and takes initiatives to protect and honor trees of significant ecological, cultural, and historical

value across the state. There are currently 32 trees that have been identified under this and the species considered are Banyan, Peepal, Pakad, Mahua, Neem, Khirni , Semal, Gular, Tamarind , Kalpavriksha and Kanak Champa. The Baobab as mentioned above is not a native species for India but the history that comes with these resilient and formidable trees, makes it a very suitable contender for a heritage tree in Patna and Bihar. This step I feel will acknowledge and also honour the lesser known but ancient botanical treasure that we have here.

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Kanwar Lake: Changing Fish Diversity and the Need to Restore Its Ecological Connections

Ved Prakash Saini and Mamta Singh*

Kanwar Lake, located in Bihar, is one of the most important freshwater wetlands of the region and was recognised as a Ramsar wetland in November 2020. This vast oxbow lake, also known as Kabartal Wetland, has historically provided a rich and diverse habitat for fish because of its seasonal connection with the surrounding floodplains and the Ganga system. These connections allowed fish to move into the wetland during floods, breed, find food and provide a natural source of young fish for the lake.

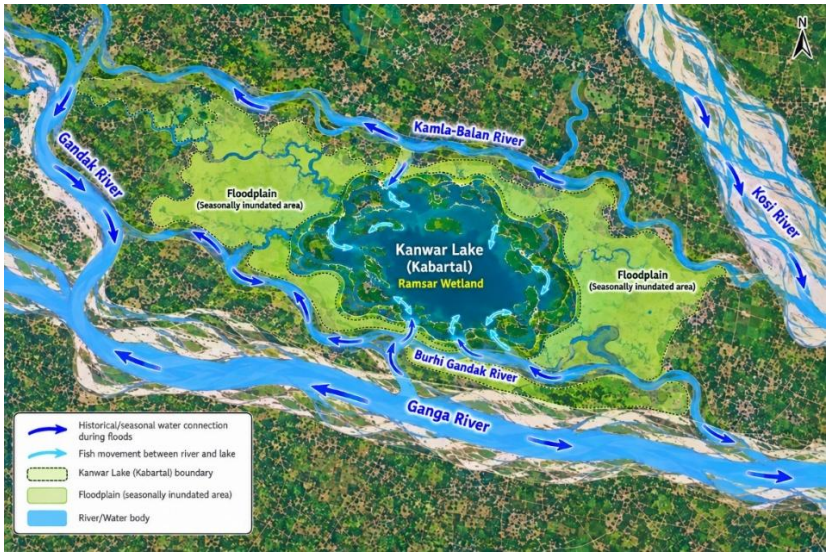


Figure 1: Illustration (not to scale) showing Kanwar Lake, its floodplain and its historical hydrological connection with the Ganga river system.

Over the years, however, the fish diversity of Kanwar Lake appears to have changed considerably. Earlier studies recorded around 35 resident fish species, while later reports indicated the occurrence of nearly 50 species, including several riverine and migratory fishes that entered the wetland during floods. A more recent survey recorded 26 ornamental fish species, although this survey had a different focus and therefore cannot by itself be taken as a complete measure of the lake's present fish diversity. Nevertheless, historical records point towards a gradual change in the composition of the fish community.

One of the most noticeable changes is the decline of large riverine and migratory fishes. Species such as rohu, mrigal, catla, tengra, pabda and freshwater catfish were historically associated with the lake and its seasonal flood connections. These fishes depend on suitable water movement, connected habitats and seasonal migration for successful breeding and recruitment. As these natural connections have weakened, their ability to reach suitable breeding and nursery grounds has also been affected. At the same time, fishes that can survive under difficult environmental conditions appear to be becoming more prominent. Air-breathing fishes, such as magur, singhi, kawai and kuchia, can tolerate shallow water, low oxygen and stagnant conditions. Their increasing presence may therefore be viewed as an indication that the wetland environment is becoming less favourable for species that require cleaner, deeper or flowing water. Hardy indigenous fishes such as snakeheads and several small indigenous fishes continue to survive because of their ability to adapt to changing environmental conditions.

Table 1: Comparative Diversity Among Major Fish Groups

Fish Group	Historical Status	Present Trend
Riverine catfishes	High	Declining
Air-breathing fishes	Moderate	Increasing
Snakeheads (*Channa* sp.)	Stable	Stable to increasing
Ornamental cyprinids	Rich	Moderate
Eels	Stable	Stable
Migratory fishes	Common during floods	Reduced



Riverine catfish species (*Eutropiichthys vacha*)



Riverine catfish species (*Mystus cavasius*)

Figure 2: Constantly decreasing riverine catfish species in Kanwar Lake



Snakehead (*Channa punctata*) **Air-breathing fish (*Anabas testudines*)**

Figure 3: Persistently high abundance (*Channa punctata*) and constantly increasing air-breathing (*Anabas testudines*) fish reported from Kanwar Lake in recent years.

Why is Kanwar Lake changing?

The most important concern is the weakening of the natural connection between the lake and the Ganga–Gandak river system. Seasonal flooding once acted like a natural lifeline, allowing adult fish to enter the wetland, young fish to disperse, and populations to be naturally replenished. Reduced flooding and changes in drainage and water flow have weakened this process. Siltation is another major problem. The gradual accumulation of sediments has made parts of the lake shallower and has converted open-water areas into marshy habitats. This reduces deep-water refuges and suitable breeding grounds for several fish species. Dense growth of water hyacinth and other aquatic weeds further restricts fish movement, reduces light and can lower oxygen levels in the water. Other pressures, including excessive fishing, capture of juvenile fish, habitat fragmentation and changing rainfall patterns, can further affect fish populations. Irregular monsoon conditions may disturb the timing of breeding and migration, while activities around the wetland can reduce important nursery and breeding habitats.

Protecting the fish diversity of Kanwar Lake

The changing fish community of Kanwar Lake is not simply a matter of losing a few fish species. It is a reflection of the overall health of the wetland. Restoring and maintaining natural water connectivity, controlling excessive siltation and aquatic weed growth, protecting breeding and nursery areas, and promoting responsible fishing practices can help the lake regain its ecological strength. Kanwar Lake is more than a water body—it is a living ecosystem that supports fish, birds, plants, fisheries and local communities. Protecting its natural connections with the surrounding river and floodplain system will be essential for conserving its fish diversity and sustaining its fisheries resources for future generations. The available evidence strongly suggests that restoring the wetland's hydrological connectivity should be at the heart of its long-term conservation strategy.

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Dudhi ***Wrightia tinctoria***

Review and Research
समीक्षा और शोध

Biodiversity Mainstreaming in Urban Master Plans: A Systematic Review of Historical and Contemporary Planning Approaches

Anjali Sharma[1]*, Anushri Barman[1], Kritika[1], Rahul Kumar[1]

A B S T R A C T

Rapid urbanization has transformed natural habitats, wetlands, river corridors, agricultural landscapes and other ecological systems, making biodiversity conservation increasingly relevant to statutory spatial planning. Urban master plans are particularly important because they determine land-use allocation, development intensity, environmental safeguards, open-space systems and infrastructure priorities. However, biodiversity is frequently represented indirectly through green areas, parks, water bodies, conservation zones or environmental protection provisions rather than through explicit ecological objectives, measurable targets, connectivity strategies and implementation mechanisms. This PRISMA 2020-aligned systematic literature review examines how biodiversity has been incorporated into urban planning and master-planning instruments from the emergence of modern urban biodiversity scholarship in the 1990s to the contemporary policy and planning literature available up to August 2026. The review synthesizes historical and contemporary evidence on biodiversity baseline information, habitat and species conservation, ecological connectivity, green and blue infrastructure, wetlands and rivers, ecosystem services, biodiversity-sensitive zoning, development controls, restoration, quantitative targets, monitoring, governance and community participation. The literature indicates a clear conceptual progression: from protecting isolated green spaces and natural remnants, through ecosystem services and ecological networks, towards biodiversity mainstreaming, nature-based solutions, measurable targets and multi-level implementation. Nevertheless, the evidence also identifies a persistent implementation gap. The review therefore proposes a Biodiversity Provision Assessment Framework for analysing master plans. Existing planning documents identify conservation, water-body, open-space and bio-conservation provisions, providing a useful baseline for a more systematic assessment. The paper concludes that future biodiversity-sensitive master planning should move from broad environmental intent towards spatially explicit, measurable, enforceable and monitorable ecological planning.

Keywords: urban biodiversity; master plan; biodiversity mainstreaming; ecological planning; Blue-green infrastructure, ecological connectivity; biodiversity-sensitive planning;

1. Introduction

Urbanisation is a major land-use transformation process and is increasingly recognised as a central context for biodiversity conservation. The relationship between cities and biodiversity has changed conceptually over time. Early urban ecological research often treated the city primarily as a source of disturbance and habitat loss, whereas later work demonstrated that urban areas can contain substantial biological richness and can provide ecosystem services when ecological structure is recognised in planning and management. A review of the field notes that urban biodiversity research expanded markedly from the 1990s onward, although research remains uneven geographically and taxonomically. The 2000 literature explicitly argued that biodiversity concepts such as scale, fragmentation, habitat structure and species identity could be applied to urban ecosystems and management.

The planning importance of such a paradigm shift is considerable. Master plans are not biodiversity plans, instead, they are vision documents or statutory spatial planning or strategic instruments organizing future urban growth. The biodiversity importance of Master Plans resides in their decision-making regarding land use regulation and development potential regarding preservation of ecological resources, river and wetland management, connection of green spaces, development control in sensitive areas and ecological goals as well as their realization in implementation and monitoring mechanisms. The difference is crucial since a Master Plan may have a large amount of 'green' information without necessarily providing a solid biodiversity policy.

In that respect, this research outlines the process of moving from identifying provisions to evaluating gaps and translating good practices into the recommendations for future Master Plans, and particularly highlights the baseline ecology, natural ecosystems, habitat and species protection, connectivity, blue-green infrastructure, land use planning, development control, ecosystem services, restoration, built environment measures, quantitative targets, monitoring, governance, participation and implementation as assessment categories candidates.

A need for this type of a framework is also supported internationally. One such research reviewed 135 plans from 40 cities and found that habitat conservation, air and water quality, cultural ecosystem services and ecological connectivity were common attributes, but quantitative targets were uncommon. Biodiversity integration into planning instruments in Kumasi, Ghana was limited and often secondary to health, safety and economic priorities. City biodiversity plans can contain many actions without equivalent accountability measures. More recent comparative research shows that regulatory systems and plan-led approaches can integrate biodiversity earlier through zoning and city planning, while discretionary systems may depend more heavily on project appraisal.

The objectives of this research are to (1) systematically review historical and contemporary literature on biodiversity provisions in urban planning instruments, and (2) develop an evidence-based framework for assessing and strengthening biodiversity provisions in the Master Plans.

For this review, a biodiversity provision is defined as a statement, land-use designation, spatial strategy, regulation, programme, target, indicator, institutional arrangement or implementation mechanism in a planning instrument that directly or indirectly

contributes to the conservation, restoration, enhancement, connectivity or sustainable management of biological diversity and its supporting ecosystems. This definition deliberately includes both explicit biodiversity language and functional provisions for example, wetland buffers or river floodplain restrictions even where the word 'biodiversity' is absent.

This distinction is essential for India because master plans frequently express ecological intent through categories such as conservation, open space, recreation, water bodies, river/flood plain, urban agriculture, forest, natural heritage or special reservation. Such provisions should not automatically be classified as biodiversity-positive. Their ecological significance depends on spatial definition, permitted and prohibited uses, development controls, ecological objectives, management responsibility and monitoring.

2. Literature Review

PRISMA 2020 has been used as the framework for reporting of identification, screening, eligibility and inclusion. The search window is January 1990 to 2 September 2026 (corresponding to the present review cut-off). A total of 65 Records were collected, where 30 Records came from Scopus, 25 from Web of Science, and 10 extra Records were collected from ScienceDirect, Google Scholar, and targeted searches from official sources. After the identification process, 18 duplicates were dropped, which leaves 47 unique Records eligible for title and abstract screening. Based on the defined inclusion/exclusion criteria for their titles and abstracts, 30 records were dropped out as they were not addressing the topic of biodiversity, ecological planning, master planning, spatial planning, green/blue infrastructure, ecological networks, and other biodiversity provisions in relation to urban planning. Therefore, 17 documents were collected and further evaluated in full text. Finally, 6 Records were dropped after the full-text evaluation due to several factors such as lack of relevance, lack of connection with urban/master planning, insufficient data about the planning provisions for biodiversity, etc.

Finally, 11 studies and relevant planning/policy documents that satisfied the eligibility criteria were included in the qualitative synthesis. These studies formed the principal evidence base for identifying recurring biodiversity provisions, planning mechanisms, implementation approaches, monitoring requirements, and research gaps. The 11 studies/documents were subsequently used to develop the Biodiversity Provision Assessment Framework for application to future Master Plans.

3. Results

Table 1 shows the core literature-review matrix. It separates papers directly analyzing planning documents from broader urban-biodiversity studies that provide conceptual or empirical justification for planning provisions.

Table 1: Literatures considered for study

No.	Paper / Study	Author(s)	Publication details	Year	Relevance to present study
1	Ecological Perspectives in Spatial Planning: Critical Review of Master Plans for Delhi	Gargi Mishra; Rutul Joshi	IIHS Urban Arc 2021: Urban Imaginaries (Conference Proceedings)	2021	Directly compares MPD 1962, MPD 2001 and MPD 2021 using the Millennium Ecosystem Assessment framework; establishes the Delhi longitudinal precedent.
2	Planning for the Future of Urban Biodiversity: A Global Review of City-Scale Initiatives	Charles H. Nilon et al.	BioScience, 67(4), 332–342	2017	Foundational framework; reviews 135 plans in 40 cities and identifies biodiversity/ecosystem-service attributes and the scarcity of quantitative targets.
3	Integration of biodiversity in urban planning instruments in developing countries: the case of Kumasi Metropolitan Assembly, Ghana	Abubakari Ahmed; Jose A. Puppim de Oliveira	Journal of Environmental Planning and Management, 60(10), 1741–1764	2017	Direct precedent for assessing biodiversity in master plans, zoning, building codes and permits; highlights weak integration and institutional barriers.
4	Current trends and issues in methods of making Green Master Plans for urban-biodiversity conservation	Naoyuki Sone; Yusuke Ueno; Masao Kurihara	Journal of the Japanese Institute of Landscape Architecture, 78(5), 615–618	2015	Shows the importance of ecological networks in Green Master Plans and the difficulty of translating connectivity into effective planning.
5	Biodiversity in cities needs space: a meta-analysis of factors determining intra-urban biodiversity variation	Joscha Beninde; Michael Veith; Axel Hochkirch	Ecology Letters, 18(6), 581–592	2015	Provides ecological evidence for habitat patch size and corridors; supports spatial connectivity criteria in master-plan assessment.
6	Actions, indicators, and outputs in urban biodiversity plans: A multinational analysis of city practice	Jennifer Rae Pierce et al.	PLOS ONE, 15(7), e0235773	2020	Analyses 39 city biodiversity plans; provides strong evidence for separating actions, indicators, outputs and accountability.
7	Mainstreaming biodiversity targets into sectoral policies and plans: A review from a Biodiversity Policy Integration perspective	Hens Runhaar et al.	Earth System Governance, 20, 100209	2024	Systematic review of 43 empirical studies; demonstrates that biodiversity mainstreaming remains low and targets are often abstract or poorly resourced.
8	Consideration of water policies in the urban development plans of Delhi: A collaborative planning perspective	Maheshwari Gupta; Rabidyuti Biswas; Ashok Kumar; Cecilia Tortajada	River, 3(3), 228–244	2024	Directly reviews Delhi MPDs 1962, 2001 and 2021 and demonstrates the value and limitations of sectoral integration, particularly for water.
9	Managing urban development for biodiversity: a cross-country analysis of local planning practices	S. Shahab; E. Falco; E. Kaplinsky; P. Lacoere; F. Wenner	Journal of Environmental Policy & Planning, 28(4), 790–806	2026	Very recent comparative study of biodiversity integration across national/regional, city/master-plan and project levels.

10	Urban biodiversity: State of the science and future directions	Norbert Müller et al.	Urban Ecosystems, 25, 1083–1096	2022	Provides a broad synthesis of the evolution, state and research gaps of urban biodiversity; useful for historical framing.
11	Biodiversity conservation in urban ecosystems: concepts and applications	Jari Niemelä	Landscape and Urban Planning, 48, 131–142	2000	Early conceptual paper connecting urban ecology, biodiversity conservation and urban management; useful for establishing the historical intellectual baseline.

3.1 Historical Evolution of the Literature: 1990–2026

The historical trajectory suggests a conceptual transition from conservation of individual ecological assets toward systems-based and implementation-oriented planning. The earliest stage emphasised recognition of urban biodiversity and ecological effects of urbanisation. The next stage introduced spatial concepts such as habitat patches, fragmentation and ecological networks. The ecosystem-services phase expanded the rationale by connecting biodiversity to flood regulation, climate moderation, recreation, water quality and human well-being. More recent work emphasises mainstreaming, indicators, targets, governance and development management.

Table 2: Historical Evolution of Literature related to Biodiversity Provisions in Master Plans

Period	Major development	Implication for planning	Key evidence
1990–1999	Urban biodiversity becomes a recognisable research field; Convention on Biological Diversity (CBD), 1992 and Agenda 21 strengthen the biodiversity-policy context.	The planning paradigm increasingly recognised cities not merely as threats to biodiversity, but as important spaces for its conservation, restoration and sustainable management.	Urban biodiversity scholarship reviewed as expanding since the 1990s (Müller et al., 2022).
2000–2007	Urban biodiversity concepts, habitat fragmentation, ecological networks and ecosystem approaches enter spatial-planning research.	Planning attention shifts from isolated parks toward habitat structure, landscape scale and ecological networks.	Niemelä (2000); Jongman et al./biotope-pattern literature (2002).
2008–2012	City Biodiversity Index/CBI and ecosystem-services approaches become operational planning tools.	Cities gain ways to baseline biodiversity and governance; ecosystem services become a planning rationale.	Singapore Index launched in 2008 and revised through expert processes; TEEB Manual for Cities (2011).
2013–2016	Green infrastructure, ecological networks and nature-based approaches gain prominence.	Biodiversity becomes increasingly connected to multifunctional green/blue infrastructure and urban resilience.	Sone et al. (2015); ETC/BD (2015); IUCN NbS framework (2016).
2017–2020	Comparative plan assessment becomes more explicit.	Researchers assess actual planning documents, attributes, actions, indicators and implementation gaps.	Nilon et al. (2017); Ahmed & de Oliveira (2017); Pierce et al. (2020).
2021–2023	Biodiversity mainstreaming, measurable targets and global urban sustainability commitments intensify.	Planning instruments are expected to link biodiversity with targets, monitoring, governance and implementation.	PRISMA 2020; Kunming–Montreal GBF (2022); contemporary urban biodiversity review.
2024–2026	Biodiversity policy integration is assessed more critically and development-management mechanisms receive greater attention.	Focus shifts toward whether biodiversity changes development decisions, zoning, regulation and project delivery rather than remaining an environmental add-on.	Runhaar et al. (2024); Shahab et al. (2026).

Nevertheless, the evidence also identifies a persistent implementation gap. Nilon et al. (2017), for example, found that few of 135 city plans from 40 cities included quantitative biodiversity targets, while Pierce et al. (2020) found that only 29% of 2,231 identified actions across 39 city biodiversity plans were directly linked to a measure. More recent work shows that biodiversity integration depends strongly on governance and the degree to which biodiversity is incorporated early in zoning and city planning rather than being treated only at the project-appraisal stage.

3.2 Results of the Evidence Synthesis

A narrative thematic synthesis is divided into 5 components of study - From green-space protection to biodiversity planning, Biodiversity integration is often weak in conventional planning instruments, Indicators and accountability remain a major gap, Ecosystem services and multifunctional planning, Mainstreaming and governance, A Biodiversity Provision Assessment Framework has been made for integration of biodiversity in master plans.

Based on the literature identified in the uploaded material and verified through the targeted web-based evidence search, the strongest evidence clusters around five themes: (i) ecological baseline and habitat conservation; (ii) ecological connectivity and green/blue infrastructure; (iii) ecosystem services and multifunctionality; (iv) measurable indicators, targets and accountability; and (v) governance, regulation and development management.

3.2.1 From green-space protection to biodiversity planning

Nilon et al. (2017) provide a foundational comparative benchmark. Their review of 135 plans across 40 cities developed attributes for biodiversity and ecosystem services and found that habitat conservation, air and water quality, cultural ecosystem services and ecological connectivity were among the most common plan attributes, while quantitative targets were comparatively rare. This finding is important for master-plan assessment because it distinguishes recognition from operationalization. The 2015 Japanese review of 20 Green Master Plans similarly found that ecological networks were rarely planned in a concrete and effective way, despite biodiversity conservation being an explicit planning objective. The study therefore supports a recurring conclusion: ecological connectivity is frequently recognized conceptually but is harder to translate into spatially explicit and implementable networks.

3.2.2 Biodiversity integration is often weak in conventional planning instruments

Ahmed and de Oliveira (2017) examined biodiversity integration across master plans, medium-term plans, building codes, zoning codes and permits in Kumasi. They reported limited integration, with many instruments historically oriented toward health, safety and economic priorities. The study also highlights institutional capacity, funding and participation as conditions affecting implementation. This is particularly relevant to Master Plans because a biodiversity-sensitive master plan cannot depend only on land-use designation; it requires institutional mechanisms capable of enforcing and maintaining those designations.

3.2.3 Indicators and accountability remain a major gap

Pierce et al. (2020) analysed 39 city biodiversity plans and identified 2,231 actions, 346 indicators and 444 outputs. All plans included actions, but only 67% included indicators and 72% included outputs; only 29% of actions were associated with a measure. The authors also identified additional topics such as socioeconomic considerations, data collection, genetic diversity, urban agriculture and forestry, green infrastructure, human-wildlife conflict, indigenous concerns and citizen science. These results strongly support including monitoring and accountability as separate dimensions in a master-plan biodiversity assessment.

3.2.4 Ecosystem services and multifunctional planning

The ecosystem-services perspective broadened biodiversity planning beyond species protection. The TEEB Manual for Cities (2011) translated ecosystem services into an urban-management perspective, while later green-infrastructure and nature-based-solutions literature connected ecological systems with stormwater management, heat mitigation, recreation, climate adaptation and resilience. The IUCN's 2016 nature-based solutions framework further positioned ecosystem-based approaches as tools for addressing societal challenges. For master plans, this means that biodiversity can be embedded in land-use and infrastructure decisions rather than treated as a separate environmental chapter.

3.2.5 Mainstreaming and governance

Recent biodiversity-policy integration literature indicates that mainstreaming remains uneven. Runhaar et al. (2024), reviewing 43 empirical studies on biodiversity policy integration, found overall levels of integration to be low, with targets often too abstract and resources insufficient to address drivers of biodiversity loss. The implication for spatial planning is that biodiversity should be integrated into the mechanisms that drive land transformation—zoning, development permissions, infrastructure investment and development controls—rather than being added as a parallel environmental aspiration. Shahab et al. (2026) provide a particularly contemporary planning perspective. Their cross-country analysis of Manchester, Bologna, Calgary, Frankfurt and Ghent examined biodiversity across national/regional, city and project levels. The study found that Frankfurt, Bologna and Calgary placed greater emphasis on early-stage integration through zoning and city planning, whereas other contexts relied more on discretionary project-level processes. This reinforces the importance of embedding biodiversity at the master-plan stage.

3.3 Inclusion of City Biodiversity Index (CBI)

Indicators and accountability are the most critical gaps that still need to be addressed in relation to biodiversity sensitive master planning. While there has been increasing recognition of the importance of biodiversity and ecosystem services, the master plan lacks clear and measurable indicators and tools to monitor the results. City Biodiversity Index (CBI) is an indicator tool that was designed through the Singapore experience and introduced in 2008, which is supplemented by the TEEB Manual for Cities of 2011. However, CBI indicators cannot be applied in the same way in different cities. Future master plans should therefore integrate city-specific CBI indicators, baseline assessments, measurable targets and periodic monitoring**,** with CBI findings informing planning recommendations, implementation and accountability.

3.4 Biodiversity Provision Assessment Framework

The 17-domain framework developed from the systematic literature review provides a structured tool for assessing the extent to which biodiversity considerations are integrated into statutory spatial planning. It moves beyond simply identifying whether biodiversity is mentioned in a master plan and examines what is protected, where it is spatially integrated, how it is regulated, who is responsible, whether targets are measurable, and how implementation can be monitored**.** The framework therefore assesses biodiversity mainstreaming across ecological, spatial, regulatory, institutional and implementation dimensions. each domain can be assessed on the basis of documentary evidence and classified according to the strength and nature of the provision for any master plan. Each domain should be coded at five levels: 0 = absent; 1 = mentioned; 2 = spatially designated; 3 = regulated/quantified; 4 = regulated + measurable + implementable + monitored.

*Table 1: The **17-domain framework t**o assess the extent of integrating biodiversity considerations into Master Plans*

Domain	What to assess	Example evidence	Suggested score 0–4
1. Biodiversity baseline	Species, habitats, ecological inventories, maps	Biodiversity atlas/GIS baseline	0–4
2. Natural ecosystems	Forests, wetlands, rivers, floodplains, agricultural ecosystems	Mapped ecological assets	0–4
3. Habitat conservation	Sensitive habitats and protected ecological areas	Conservation zone, habitat reserve	0–4
4. Species conservation	Threatened/endemic/priority species	Species/habitat protection provisions	0–4
5. Ecological connectivity	Corridors, stepping stones, networks	Continuous green/blue network	0–4
6. Green infrastructure	Parks, urban forests, street trees, greenways	Green network standards	0–4
7. Blue infrastructure	Rivers, wetlands, ponds, drainage, riparian areas	Buffers/floodplain zones	0–4
8. Biodiversity-sensitive zoning	Land-use allocation for ecological function	Conservation/bio-conservation zone	0–4
9. Development controls	Buffers, setbacks, prohibited uses, tree controls	Permitted/prohibited use table	0–4
10. Ecosystem services	Flood control, cooling, carbon, recreation, water purification	ES mapping/assessment	0–4

11. Restoration	Wetland/river/degraded-land restoration	Restoration programme	0–4
12. Built-environment biodiversity	Green roofs/walls, bioswales, habitat features	Building/development standards	0–4
13. Quantitative targets	Green cover, canopy, habitat/wetland targets	Percent/area targets with dates	0–4
14. Monitoring	Indicators, GIS, periodic assessment	Annual biodiversity dashboard	0–4
15. Governance	Agencies, responsibilities, coordination	Institutional assignment	0–4
16. Participation	Citizen stewardship, local knowledge, education	Participation mechanisms	0–4
17. Implementation	Funding, action plans, phasing, enforcement	Budget + timeline + responsible agency	0–4

How the framework will be used:

The framework can be applied to the future master plans through a document-based assessment. For each domain, the plan can be examined for the presence of relevant policy statements, spatial designations, regulations, targets, implementation mechanisms and monitoring provisions. This allows the analysis to distinguish between a provision that is merely recognised in policy and one that is spatially defined, legally supported and capable of implementation. The 17 domains therefore provide the analytical bridge between the systematic literature review and the empirical assessment of master plans. They transform the findings of the literature into a replicable framework that can identify not only where biodiversity is addressed, but also how comprehensively and operationally it is embedded within the master-planning process.

3.5 Application of the Biodiversity Provision Assessment Framework to Urban Master Plans:

The Biodiversity Provision Assessment Framework developed through the systematic literature review is intended as a general analytical tool for evaluating the extent to which biodiversity considerations are integrated into urban Master Plans. Rather than being restricted to a particular city or planning system, the framework can be applied to statutory Master Plans, comprehensive plans, development plans and other spatial planning instruments. This offers a systematic framework to analyze whether biodiversity is merely a policy goal or whether it has been transformed into spatial designation, regulation, quantified targets, implementation measures, and monitoring systems. For applying the framework on any Master Plan, all 17 themes need to be analyzed using systematic documentation and content analysis. Applicable provisions need to be identified from the Master Plan vision and goals, current land use map, proposed land use plan, zoning regulations, development control regulations, environmental policies, infrastructure policies, implementation policies, and monitoring systems. Evidence needs to be documented considering the spatial, regulatory, quantifiable, institutional and implementation aspects of each provision. Assessment needs to be made on whether there is a mention of any biodiversity-related provision in the plan or its operational effectiveness in the plan. Provision can be mentioned only, spatially designated, developmentally regulated, quantified or even implementation and monitoring mechanism may be provided. This differentiation is in line with the framework that has been developed which classifies the provision at five levels of scoring, namely, 0 - no provision; 1 - mention; 2 - spatially designated; 3 - regulated/quantified;

and 4 - regulated, measurable, implementable and monitored. Master Plans offers a unique opportunity to make an analysis of the differentiation between ecological land use designation and biodiversity mainstreaming. A plan might have conservation zone, river and water body control, open spaces etc., but may not have many provisions regarding biodiversity related indicators, ecological networks, measurable objectives and monitoring system. However, instead of taking these shortcomings for granted, the proposed assessment will identify these shortcomings systematically through the 17-domain framework. This analysis goes beyond the question "Does the master plan address biodiversity?" and poses much more relevant questions such as "how, where biodiversity was addressed, by whom, whether the targets are measurable and how can the results be monitored?" Through this analysis, one will be able to gain better insights on the degree to which biodiversity has been integrated into the statutory planning system.

4. Analysis

Based on the systematic evidence, however, biodiversity mainstreaming within urban planning appears to be a matter of degree – one located at some point along a continuum of increasingly strong planning commitment and capacity to implement planning measures. Indeed, the literature proposes a fairly consistent pattern where biodiversity integration proceeds from policy acknowledgment to spatial designations, further to regulatory integration and, finally, to implementation-oriented integration. In the first step, biodiversity is recognized in terms of vision statements or policy goals. While providing the necessary institutional acknowledgment, this type of integration offers very little in terms of actual protection in the absence of any spatial or regulatory mechanisms. In the second stage, the ecological agenda is translated into a spatial arrangement through the establishment of conservation areas, green spaces, wetlands, ecological corridors or any other land use category. In the third stage, the process is reinforced through development restrictions such as buffer zones, setbacks, permitted and prohibited uses and other regulatory tools. The fourth stage links these spatial and regulatory arrangements to target indicators and other implementation mechanisms. The literature demonstrates that the mere presence of biodiversity-related terminology or conservation zones should not be interpreted as evidence of effective biodiversity planning. A conservation designation may have limited practical value if its ecological purpose, spatial boundary, permitted-use regime, management authority and monitoring requirements are unclear. Similarly, quantitative targets for parks or green spaces may increase the provision of recreational areas without necessarily improving native biodiversity, habitat quality or ecological connectivity. The quality and enforceability of planning provisions are therefore as important as their presence.

Spatial Dimension of Biodiversity Planning:

Biodiversity functions beyond administrative boundaries and individual land-use parcels. Ecological processes depend on the continuity and interaction of habitats, water systems, vegetation patches and movement corridors.

Habitat Size and Connectivity:

The review of Green Master Plans (2015) identified weaknesses in planning ecological networks, while Beninde et al. (2015) established positive relationships between habitat area, connectivity and urban biodiversity**.** Thus, biodiversity planning should move beyond measuring only the total area or per-capita provision of green space.

In Cities, rivers, floodplains, wetlands, water bodies, agricultural areas, institutional open spaces and urban green spaces should be planned as interconnected urban ecological network rather than isolated resources, supporting habitat continuity, flood regulation, water retention, microclimatic regulation and ecosystem services. The Master Plans should therefore be assessed to determine whether these ecological assets are merely designated individually or spatially integrated through meaningful ecological linkages.

Integrating biodiversity into development management:

The findings also reveal the importance of integrating biodiversity into development management rather than treating it as a separate environmental sector**.** Current studies also stress the importance of when biodiversity considerations come into play during the planning process. Inclusion of biodiversity into the city-planning and zoning process may affect the siting, scale and form of the proposed development before projects are approved. The 2026 evidence from the country-wide study demonstrates that how high up in the governance hierarchy the inclusion of biodiversity occurs may have a large impact on the course of development. It implies that the conservation of biodiversity should happen upstream of spatial planning instead of through the project-based environmental assessment downstream of development. Biodiversity considerations should be considered in various tools of planning, such as land use zoning, infrastructure corridors, management of rivers and flood plains, development control, open space system, and area-based implementation plan. The inclusion of biodiversity in the infrastructure planning process is especially important since the infrastructure planning, such as roads and transport corridors, can fragment ecosystems and change drainage and hydrology.

It is further made clear in the review that implementation is the key connecting planning intentions to the ecological impacts of those intentions. Good planning in terms of biodiversity entails not only the identification of the sensitive areas but also entails the specification of roles, coordination, money, enforcement, and monitoring. This becomes especially relevant for the Indian cities where statutory plans may have proper environmental targets but those plans may become ineffective due to fragmented roles, development pressures, and insufficient monitoring. Therefore, while evaluating Master Plans, there must be a differentiation of provisions which are just mentioned, provision that are spatially defined, those which are regulated, and those having implementation mechanisms. Collectively, these results provide a strong case for adopting the 17-domain analytical framework produced via the systematic review as an instrument for assessing the integration of biodiversity mainstreaming within master planning. Rather than giving a weight to the presence of certain biodiversity-related provisions as the sole criterion, this analytical framework will be able to measure how

comprehensively and thoroughly biodiversity is integrated into planning domains. This will help determine if Master Plans address biodiversity only through conservation provisions or if the ecology has been considered within all other planning domains.

The above analysis highlights that instead of using a "green space provision" approach, the "ecological planning" approach should be considered. While the first focuses on the quantity of green space provided by any plan, the latter includes ecological networks, quality of habitats, connectivity, function of ecosystems, development pressure and implementation mechanism within its scope. This new trend of shifting focus is in line with the evolutionary process observed in urban biodiversity literature review.

4.1. Framework for Future Assessment of Master Plans

After the systematic literature review, the empirical Master Plan phase should be done as structured document/content analysis rather than an extension of the literature review. It is recommended to proceed in the following manner:

1. Gather the relevant Master Plan documents which include the notified plan, land use map, zoning, development control, implementation and relevant sectoral planning documents.
2. Systematically search the documents using a controlled biodiversity-planning vocabulary that includes biodiversity, conservation, bio-conservation, natural heritage, river, flood plain, wetland, water body, forest, green, ecological, habitat, wildlife, tree, corridor, buffer, restoration, environment and ecosystem.
3. Code each relevant provision according to the 17-domain Biodiversity Provision Assessment Framework.
4. Record the nature of each provision, including spatial location, land-use category, permitted/prohibited uses, development-control strength, quantitative targets, implementation responsibility and monitoring requirements.
5. Assign a score on the domain level ranging from 0 to 4 based on the scoring criteria of the framework.
6. Calculate scores at domain level and for the overall framework while maintaining the underlying documentation so that the assessment can be transparent and auditable.
7. Determine strengths, partial provisions and gaps and formulate recommendations for biodiversity sensitive Master Planning.

5. Conclusion

This review show that biodiversity is progressively becoming an important part of urban spatial planning by way of green-blue infrastructure, ecological networks, ecosystem services, and nature-based solutions. There are however limitations in integrating biodiversity into statutory master planning in terms of spatial delineation, measures, implementation, institutional management, and monitoring. It can be suggested that biodiversity should be integrated into the master planning framework and not as a stand-alone environmental issue. It should involve the protection and connectivity of ecological assets, the integration of natural systems into the land use planning process, biodiversity-informed development controls, and measurable targets and monitoring.

The 17-domain framework developed through the study provides a systematic basis for evaluating these aspects and identifying strengths and gaps in the existing Master Plan. The study further recommends the inclusion of a City Biodiversity Index (CBI) as a baseline and monitoring mechanism, with indicators adapted to the geographical and ecological characteristics of cities. This can support measurable targets, periodic assessment and greater accountability.

The study proves beyond any reasonable doubt that biodiversity-conscious master planning calls for a transition from merely understanding to taking concrete measures for implementation in terms of incorporating ecological networks, land use controls, biodiversity performance indicators, institutions, and monitoring within the statutory planning process. This model can be replicated in other Indian cities for biodiversity mainstreaming.

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Litchi Stink Bug (*Tessaratoma javanica*): Damage and Biocontrol by Hymenopterous Wasps

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Abstract

The litchi stink bug, *Tessaratoma javanica* (Thunberg) (Hemiptera: Tessaratomidae), has emerged as a serious pest of litchi (*Litchi chinensis* Sonn.) in eastern India, particularly in Bihar, Jharkhand and adjoining litchi-growing regions. Both nymphs and adults damage tender shoots, flowering panicles and developing fruits through sap-sucking activity, resulting in fruitlet abortion, poor fruit development, reduced yield and economic losses. The pest is characterized by a prolonged life cycle, high reproductive potential, migratory adult behaviour and the ability to survive on alternate host plants, which contribute to its persistence and seasonal reinfestation. Biological control through egg parasitoids offers an environmentally sustainable approach for suppressing pest populations before the emergence of damaging nymphs. The present account highlights the damage potential of *T. javanica*, its establishment in Bihar, and the role of *Anastatus* egg parasitoids in natural pest regulation. Field observations indicated that stink bug incidence occurred across different phenological windows of litchi, whereas parasitization by *Anastatus* sp. was recorded for a limited period. Most of time no parasitization was detected despite the presence of the pest. This temporal pattern may be associated with host–parasitoid synchrony, availability of suitable stink bug egg masses and prevailing orchard environmental conditions. Conservation of native parasitoids, phenology-based monitoring, orchard sanitation, area-wide management and judicious insecticide use are key to IPM. Further research should address parasitoid identity, host specificity, seasonal activity, mass rearing, field efficacy and biosafety, particularly non-target effects on beneficial insects and silkworms, before augmentative release.

Keywords: *Anastatus*; biological control; egg parasitoid; integrated pest management; *Litchi chinensis; Tessaratoma javanica*; litchi stink bug; phenology; Bihar.

Introduction

Litchi (*Litchi chinensis* Sonn.), popularly known as the "queen of subtropical fruits," is an important fruit crop of India, particularly in the eastern states of Bihar, Jharkhand and West Bengal. India produces approximately 746,000 metric tonnes of litchi annually from around 98,180 hectares, with an average productivity of about 7.6 tonnes per hectare (**GOI, 2024)**. Despite its economic importance, several insect pests challenge litchi production, and the litchi stink bug, *Tessaratoma javanica* (Thunberg) (Hemiptera: Tessaratomidae), has emerged as a serious regional threat. Once considered a minor or insignificant pest, have increasingly affected litchi orchards in eastern India. The pest was reported during outbreaks in Jharkhand in 2011–2012, and its substantial impact in Bihar was documented subsequently. Severe infestations have been associated with fruit-set losses of 70–90%, while near-total crop loss has also been reported in severely affected orchards (Choudhary et al., 2013; Kumar et al., 2022; Samal et al., 2025a).

Biology, Host Range and Establishment of Litchi Stink Bug in Bihar

The litchi stink bug is a large, reddish-brown, sap-sucking insect measuring approximately 20–25 mm in length. It belongs to the family Tessaratomidae and possesses well-developed metathoracic stink glands that produce a characteristic defensive secretion. The insect undergoes egg, nymphal and adult stages, with five nymphal instars before reaching maturity. Females generally lay eggs approximately 13 days after mating, usually in clusters of about 14 eggs on leaves, flowers and fruit surfaces. The eggs hatch in approximately 12.8 days, with a reported hatch rate of nearly 97%. Under laboratory conditions, the complete egg-to-adult development period is approximately 142 days, indicating a relatively prolonged life cycle that may support its persistence in litchi-growing ecosystems (Samal et al., 2025). The litchi stink bug is not restricted to litchi alone and exhibits oligophagous feeding behaviour. In addition to litchi, its host range includes longan (*Dimocarpus longan*), rambutan (*Nephelium lappaceum*), pomegranate (*Punica granatum*), pummelo, Kusum (*Schleichera oleosa*), champak, castor, mulberry, rose, eucalyptus, loquat and Mahua. Although litchi remains its primary economic host, the availability of alternate host plants may facilitate pest survival, dispersal and movement between orchards and surrounding vegetation. The possibility of overwintering adults surviving on alternate hosts and becoming active during the subsequent litchi-growing season further increases the risk of seasonal reinfestation. Thus, the presence of alternate hosts should be considered while developing regional surveillance and integrated pest management strategies (Wu et al., 2020; Samal et al., 2025a, b).

In Bihar, *T. javanica* has shifted from a relatively minor pest to an established and economically important pest of litchi. The initial infestation was observed in 2018 on a few litchi trees in Mehsi block of East Champaran, followed by severe and widespread outbreaks from 2021 onwards. Recent surveys conducted by ICAR–National Research Centre on Litchi (ICAR–NRCL) have confirmed its establishment in several commercial litchi-growing areas of Bihar. Under severe infestation conditions, the pest has the potential to cause approximately 40–100% crop loss. It has been recorded from important litchi-growing areas of Muzaffarpur and East Champaran, including Rohua, Mushahri, Minapur, Jamalabad, Raghopur, Jaminmathiya, Bishunpur Bazar and Mehsi. Heavy infestations have been observed on flowering panicles and developing fruits, posing a serious threat to litchi productivity, fruit quality and farmer livelihoods.

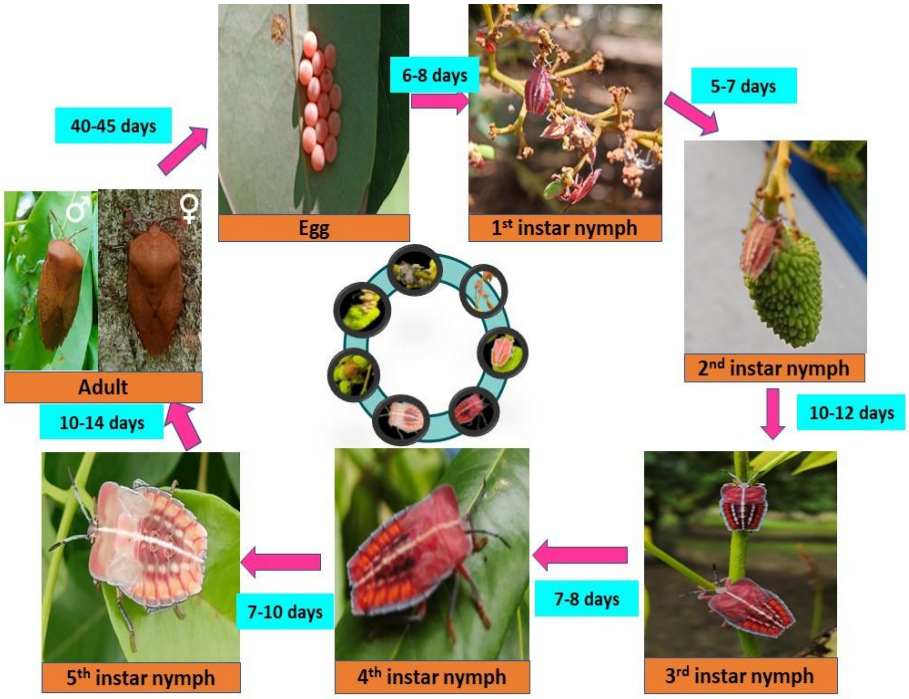


Figure 1. Life cycle of litchi stink bug, *Tessaratoma javanica*

The establishment and rapid spread of *T. javanica* in Bihar may be associated with its migratory adult behaviour, prolonged life cycle, high reproductive potential and congregating nymphal stages. Adult bugs can move between neighbouring orchards, resulting in rapid reinfestation even after insecticide application. Consequently, untreated or poorly managed orchards may serve as reservoirs for pest resurgence and may reduce the effectiveness of isolated orchard-level control measures. The situation is further complicated by asynchronous egg hatching, delayed detection of early nymphal colonies and inadequate synchronization of management practices among neighbouring growers. Field observations by the Litchi Stink Bug Task Force indicated that delayed or missed insecticide applications during critical crop stages were associated with increased pest incidence, whereas coordinated management across neighbouring orchards offered better prospects for pest suppression. The expanding distribution, increasing infestation intensity and limitations of independent orchard-based management indicate that the litchi stink bug is no longer restricted to isolated outbreaks. It has become an emerging regional and national threat to litchi production, particularly in the major litchi-growing belts of Bihar and adjoining states.

Damage caused by *Tessaratoma javanica*

The damage caused by the litchi stink bug is primarily associated with the feeding activity of both nymphs and adults. These insects use their piercing-sucking mouthparts to extract sap from tender plant tissues. During feeding, they may penetrate flower buds, inflorescences and immature fruits, injecting saliva into the plant tissues. This feeding activity can cause wilting, necrotic lesions and abortion of fruitlets. Damaged panicles may become defective, while the fruits that remain may be small or malformed. In heavily infested plants, chlorosis of leaves may also be observed. Such damage directly affects fruit set, fruit development and

the final marketable yield of litchi (Samal et al., 2025b). The occurrence of stink bug is closely associated with litchi crop phenology. Field research indicates that egg laying occurs from February onwards, with predominant activity during March and April. In unsprayed orchards of Jharkhand, egg masses and nymphal activity were reported to peak during March and decline towards late April. Observations at ICAR–National Research Centre on Litchi further indicate that pest populations may persist throughout the year, with two distinct population peaks: one during the vegetative phase associated with the rainy season and another during the flowering stage. These observations emphasize the importance of monitoring the pest before and during flowering, as well as during the early nymphal period following the rainy-season population increase (Malhotra et al., 2018; Samal et al., 2025a). The economic consequences of stink bug infestation can be substantial. The attached article reports that severe outbreaks in Jharkhand and Bihar have caused major financial losses, while outbreaks in Bangladesh during 2020–2021 were associated with a decline in litchi productivity. Because litchi is an important livelihood crop for smallholder farmers, uncontrolled stink bug populations can threaten farm income and marketable production. The pest also produces a malodorous defensive secretion when disturbed, which may cause skin irritation and a burning sensation on contact. The unpleasant odour can complicate harvesting and handling activities (Mondal et al., 2021; Schoeman, 2012).

Nature's tiny allies: Anastatus egg parasitoids

Biological control offers an important opportunity to manage litchi stink bug populations through the action of natural enemies. Among the most promising natural enemies are egg parasitoids belonging to the genus *Anastatus*. These tiny wasps attack the eggs of stink bugs, developing inside the host egg and preventing the emergence of a healthy stink bug nymph. In this way, parasitoids can suppress the next generation of the pest before it reaches the damaging nymphal and adult stages. The reports by Choudhary et al. (2015) identified three parasitic wasps associated with *T. javanica* eggs in India: *Anastatus bangalorensis*, *Anastatus acherontiae* (Eupelmidae), and an *Ooencyrtus* species (Encyrtidae). Among these, *A. bangalorensis* was reported to parasitize approximately 46% of stink bug eggs during March in an unsprayed orchard. This finding highlights the potential contribution of naturally occurring egg parasitoids to the regulation of litchi stink bug populations and the possibility of reducing dependence on insecticides through conservation of beneficial insects (Choudhary et al., 2015).

How does Anastatus control stink bug?

The biological control process begins when a female *Anastatus* wasp locates a suitable stink bug egg mass on a plant surface. Using its ovipositor, the female inserts an egg into the host egg. The developing parasitoid larva consumes the contents of the stink bug egg, thereby preventing the normal development of the pest embryo. Instead of a stink bug nymph emerging from the egg, a new adult parasitoid eventually emerges. Through this process, egg parasitism reduces the number of stink bug individuals entering the damaging nymphal and adult stages. The presence of egg parasitoids in litchi orchards therefore represents an important natural biological control service (Choudhary et al., 2015).

Evidence of natural control in litchi orchards

The study by Choudhary et al. (2015) revealed that this egg parasitoid is particularly important because it documented natural parasitization of *T. javanica* eggs in Indian litchi orchards. The reported parasitization by *A. bangalorensis* reached approximately 46% during March in unsprayed orchards. This suggests that naturally occurring parasitoids may play a meaningful role in suppressing pest populations during the period when stink bugs are actively laying eggs. The importance of these findings extends beyond the direct mortality of stink bug eggs. When parasitoids are conserved, they may contribute to lower pest pressure and reduce the need for repeated insecticide applications. This is especially relevant in litchi, where flowering attracts pollinators and where indiscriminate pesticide use can negatively affect beneficial insects. Nevertheless, parasitization observed in a particular orchard and season should not automatically be treated as a guaranteed level of control across all litchi-growing regions (Choudhary et al., 2015).

Litchi stink bug incidence was recorded across different phenological windows of litchi; however, parasitization by *Anastatus sp.* was observed only during SMW 19–27. No parasitization was detected during the remaining observation periods despite the presence of the pest. The occurrence of parasitism during SMW 19–27 coincided mainly with the fruit-development, colour-break and fruit-maturation stages. This seasonal pattern suggests that parasitoid activity was closely associated with the availability of suitable host egg masses and may have been influenced by host–parasitoid synchrony and prevailing orchard environmental conditions. The absence of parasitization during other crop stages may indicate a temporal mismatch between stink bug oviposition and parasitoid activity.

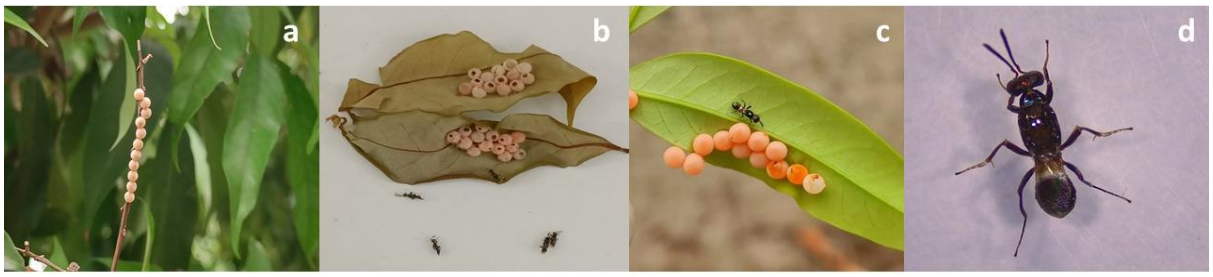


Figure 2. Parasitisation of litchi stink bug, *Tessaratoma javanica* eggs by *Anastatus* sp.

Conservation biological control: Protecting beneficial wasps

Conservation of naturally occurring parasitoids should be an important component of litchi stink bug management. Farmers can support natural biological control by regularly monitoring orchards for egg masses and nymphal aggregations, avoiding unnecessary insecticide applications and preserving suitable habitats for beneficial insects. Since *Anastatus* parasitoids attack the egg stage, their activity is particularly valuable before the pest population develops into large numbers of mobile nymphs and adults (Samal et al., 2025).

Mass rearing and augmentative release: Opportunities and limitations

The potential of *Anastatus* wasps extends beyond natural parasitization. Laboratory multiplication and augmentative release could help increase parasitoid abundance during periods of high stink bug egg availability. However, the attached article clearly emphasizes that effective mass-rearing protocols for *T. javanica* and its parasitoids have not yet been established. Therefore, large-scale release of *Anastatus* should be considered a research objective rather than a universally validated farmer recommendation (Samal et al., 2025). An important biosafety consideration arises in Bihar and Jharkhand because sericulture is actively promoted in these regions. The attached article cautions that potential non-target effects on silkworms must be investigated before any augmentative release programme is undertaken. Host-specificity testing against locally reared silkworm species, semi-field confinement assays and formal risk assessment are recommended. Any future release programme should be supported by monitoring of parasitoid recovery and non-target organisms, and should follow appropriate regulatory oversight. These precautions are essential to ensure that biological control provides pest suppression without creating unintended ecological or economic risks (Samal et al., 2025).

Integrating Anastatus with other management strategies

Egg parasitoids alone may not provide complete control of litchi stink bug populations under all conditions. Their effectiveness depends on the availability of suitable host eggs, climatic conditions, parasitoid survival and the compatibility of orchard management practices. For this reason, the attached chapter advocates an integrated pest management approach that combines phenology-aligned monitoring, orchard sanitation, cultural and mechanical practices, conservation of natural enemies and judicious insecticide use. Regular scouting should focus on litchi inflorescences, tender shoots and leaf surfaces where stink bug egg masses and nymphal aggregations may be found. The chapter also recommends attention to orchard edges, where adults may aggregate, and timely interventions during early nymphal stages. Such practices can reduce pest build-up while providing opportunities to conserve egg parasitoids. Insecticides, when required, should be selected and timed carefully to minimize harm to beneficial insects and to support resistance management (Samal et al., 2025).

Future research priorities

Future research on litchi stink bug biological control should focus on the identification and evaluation of native *Anastatus* species, the development of economical mass-rearing techniques, and field validation of their pest suppression potential. Studies are also needed to understand host–parasitoid interactions, seasonal synchrony between stink bug egg laying and parasitoid activity, and the influence of temperature and humidity on parasitoid survival and parasitization. The article also highlights the need for long-term monitoring of stink bug populations, improved molecular diagnostics, and further exploration of biological control agents. The use of DNA barcoding and other diagnostic tools may help ensure accurate identification of *T. javanica* and its natural enemies, while coordinated surveillance can support regionally adapted pest management programmes (Parveen et al., 2015; Samal et al., 2025).

Conclusion

The litchi stink bug, *T. javanica*, is an emerging threat to litchi production in eastern India, particularly because of its ability to damage flowers, developing fruits and tender plant tissues. Its increasing occurrence in litchi-growing regions calls for effective, environmentally responsible and region-specific pest management. Egg parasitoids of the genus *Anastatus*, especially *A. bangalorensis*, offer a promising avenue for biological control. The documented natural parasitization of stink bug eggs in Indian orchards demonstrates the value of conserving these beneficial insects. However, successful biological control requires careful validation of parasitoid efficacy, host specificity, mass-rearing methods and field performance. Protecting nature's tiny allies can be an important step towards protecting litchi orchards. A scientifically designed IPM programme that integrates monitoring, conservation biological control and other compatible management practices can contribute to sustainable litchi production and the protection of farmer livelihoods.

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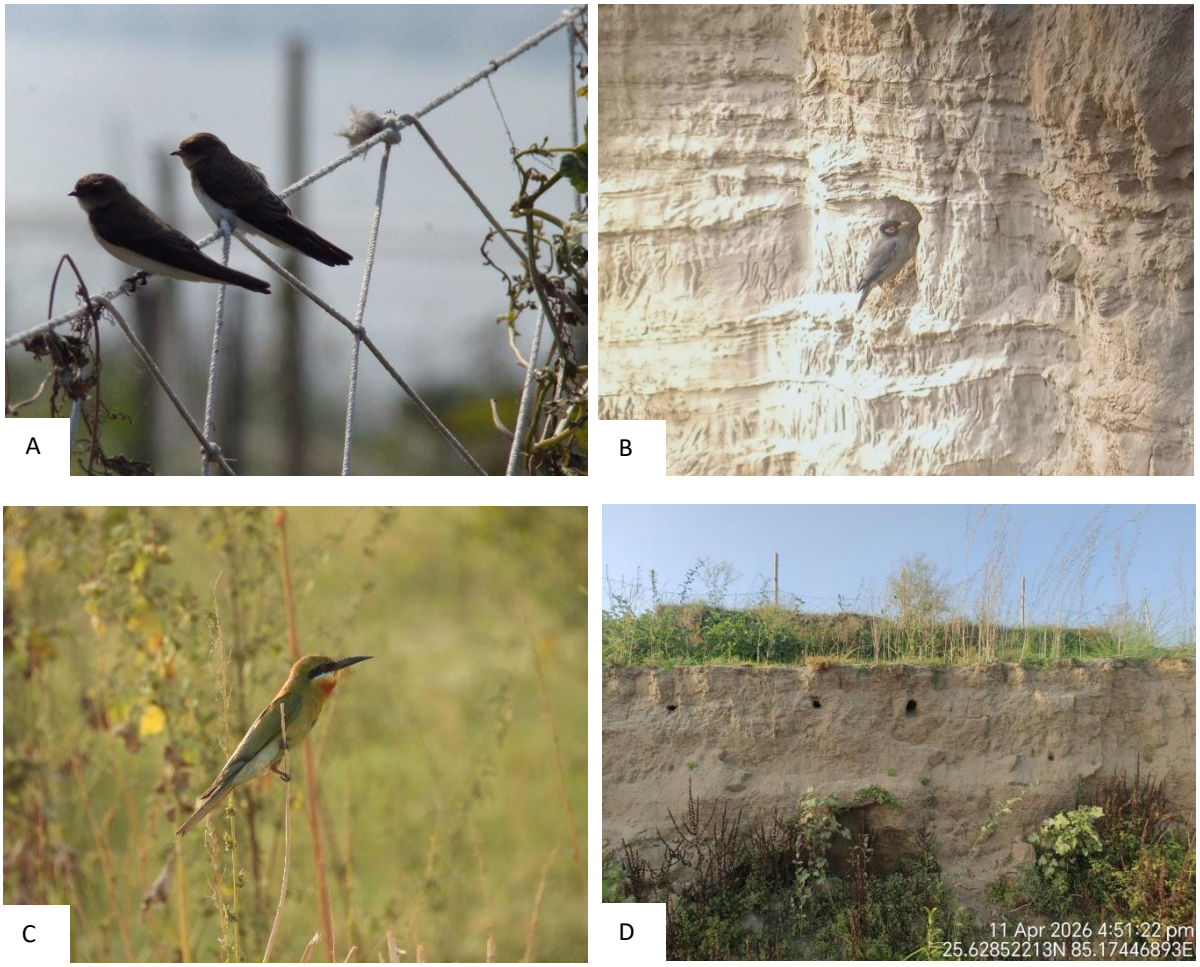


Figure 1. A. Grey-throated Martin, B. Bank Myna on its nest, C. Blue-tailed Bee Eater, D. Nesting burrows of all the three birds; visible size difference of each mentioned species

Birds in the sandbars: life in the sympatric colonies- Ganga Diara, Patna, Bihar, India

Md Shahbaz*

Introduction

Along the seasonal floodplains of the Ganga, the Bank Myna (*Acridotheres ginginianus*) takes a surprisingly hands-on approach to homebuilding: it digs its own nest straight into the earth. Nest site selection is normally understood as a careful balancing act between finding resources and avoiding danger (Resetarits, 1996). Grey-throated Martin and Blue-tailed Bee-eater are cavity-nesting birds that actively excavate their own burrows in soft, sandy substrates (del Hoyo et al., 2020; Yuan et al., 2006) (Fig 1). While most myna species across the Indian subcontinent are happy to borrow whatever space they can find, the Bank Myna prefers to excavate deep tunnels into sheer, vertical dirt walls. They almost never build alone. Instead, they dig shoulder-to-shoulder with dozens of neighbours, turning bare walls into bustling avian apartment complexes. These deep earthen tunnels serve as brilliant natural bunkers, perfectly designed to in sulate their

chicks from harsh weather and keep predators at bay (Hansell, 2000). While these birds gravitate toward river cliffs, they are just as quick to carve out their crowded neighbourhoods in the walls of brick kilns, railway cuttings, or even urban drainage embankments (Akhtar et al., 2016). Ultimately, they are not limited by a need for pristine natural habitats, but simply by the presence of a diggable vertical face (Hossain, 2025). Colonial burrow-nesting like this is thought to be a defensive trade rather than a coincidence: packing nests into one exposed wall swaps individual concealment for a crowd of extra eyes, which means faster predator detection and a better chance of driving off a threat together (Ali & Ripley, 1983; Dhindsa & Saini, 1994).

Methodology

Field Surveys: Field visits were systematically conducted during the peak season, spanning from February to June, 2026. To accurately record nesting riverine birds, field surveys employed a combination of the "Point Count Method and the Fixed-Route Monitoring" method (Ralph et al., 1993). Observations were specifically timed to align with periods of maximum avian activity. Consequently, daily surveys were executed during two primary windows: morning sessions from 7:00 AM to 10:00 AM, and evening sessions from 5:00 PM to 7:00 PM.

Nest Monitoring and Data Collection: Identified nest sites were monitored on a weekly basis. To mitigate anthropogenic disturbance to the breeding birds, all monitoring was conducted from a distance utilizing binoculars (Bushnell 30x50) and photographic documentation cameras (Kodak AZ241 & Nikon P1100) were used. Recorded parameters included the species name, the total number of nests, and the operational status of the nests (quantified as the number of occupied versus abandoned cavities). Furthermore, physical and spatial characteristics, specifically the nest diameter (cm), and precise location, were recorded for analysis. Logging every nest of three burrow-nesting species which were Bank Myna, Grey-throated Martin, and Blue-tailed Bee-eater as either occupied or abandoned.

Study Area: The study was conducted across a 3.99 km² tract of the Ganga Diara region (25°38'N, 85°08'E) (Fig 2) along the River Ganges floodplains in Patna, Bihar, India. This dynamic riparian landscape consists of seasonal floodplains and alluvial islands shaped by annual cycles of silt deposition and erosion. The substrate is predominantly moisture-retaining recent alluvium (*khadar*), comprising alternating layers of fine sand, silt, and nutrient-rich clay. While the landscape is primarily utilized for agriculture, it sustains diverse micro-habitats, including sandbars, mudflats, open floodplains, grass-dominated patches, and scattered natural riparian vegetation.



Fig 2. Study site: Ganga Diara, Patna (25°38'N, 85°08'E). Survey period: February–June, peak breeding season.

Result

Total colony sizes across the three observed species ranged from 160 to 425 nests. Despite this variance, nest occupancy rates demonstrated significant interspecific convergence, falling within a narrow margin of 11.25% to 11.53% for all three sympatric species (Table1). The Bank Myna established the largest colonies and yielded the highest absolute nest counts. Measurements of the soil burrows indicated species-specific variations in excavation dimensions. Bank Mynas excavated the widest burrows with a mean diameter of 23.4 cm (9.2 in), followed by the Blue-tailed Bee-eater at 15.2 cm (6.0 in) and the Grey-throated Martin at 10.2 cm (4.0 in). Observations of reproductive effort relative to successful occupancy revealed high energetic expenditures across the colonies. Within the Bank Myna population, an estimated 100 adult individuals maintained several hundred soil burrows along the floodplain, resulting in a final actual nest occupancy rate of <12.5%. Site characterization of the Ganga Diara nesting hasbitat during the survey period recorded continuous, concurrent anthropogenic and environmental modifications. Documented disturbances along the riverbank included active agricultural farming, livestock grazing, fishing, sand mining, and seasonal cliff erosion.

Table 1. Distribution of nest and its occupancy by birds

Species	Nests (n)	Occupied	Occupancy	SE
Bank Myna	**425**	**49**	**11.53%**	**± 1.55%**
Grey-throated Martin	195	22	11.28%	± 2.27%
Blue-tailed Bee-eater	160	18	11.25%	± 2.50%

*Occupancy = occupied nests ÷ total nests, treated as a binomial proportion; SE = standard error of that proportion.

Discussion

The highly convergent nest occupancy rates (11.25%–11.53%) across the three sympatric species, despite distinct variations in colony sizes and soil burrow dimensions, indicate that reproductive success is dictated by shared extrinsic environmental pressures rather than intrinsic biological traits. Despite high energetic investments—exemplified by the Bank Myna excavating the widest burrows and maintaining the largest colonies—overall reproductive yields remain uniformly suppressed. This interspecific bottleneck is driven by intense, concurrent stressors within the Ganga Diara ecosystem. Physical habitat degradation from sand mining, agricultural expansion, and seasonal erosion directly threatens the stability of nesting cliffs, while pesticide runoff likely depletes the invertebrate prey essential for chick rearing. Consequently, these populations face a severe energetic trade-off, expending immense physical effort in a deteriorating landscape for marginal reproductive success. Ultimately, while this heavily modified floodplain continues to function as a critical nursery for the region's colonial burrowing birds, the current rate of habitat alteration is unsustainable. The long-term viability of these avian populations relies fundamentally on the immediate conservation of contiguous, undisturbed riverbank stretches to buffer against further anthropogenic encroachment.

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The Honeysuckle Mistletoe (Banda): Significance in Urban Landscapes of Patna, Bihar

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A B S T R A C T

Hemiparasitic plants are photosynthetically active parasites that remain partially autotrophic while drawing water and mineral nutrients from a host plant, distinguishing them from fully heterotrophic holoparasites. Among such taxa, mistletoes of the family Loranthaceae, particularly the genus *Dendrophthoe,* are ecologically significant. They influence host physiology and canopy structure, supply floral and fruit resources for pollinators and frugivorous birds and act as agents of dieback in economically and aesthetically valuable trees. *Dendrophthoe falcata* (L.f.) Ettingsh., the Honeysuckle Mistletoe, is the most widely distributed and generalist mistletoe of the Indian subcontinent, recorded on several hundred host species. The main objective is to identify and document the spread of *D. falcata* across the urban landscapes of Patna, Bihar, using incidental and random sampling sites representing diverse ecosystem typologies, including roadside avenues, institutional campuses, riverfronts, vacant lands and remnant landscapes and peri-urban tract of selected areas of Patna. The study identifies the variety of host plants parasitized at surveyed sites and through an extensive literature review, evaluates the ecological significance, advantages and disadvantages of *D. falcata* within urban green infrastructure. Based on the field observations and the reviewed literature, this article proposes practical landscape management linked recommendations for monitoring and controlling the spread of *D. falcata* in Patna, balancing its biodiversity value against risks to avenues, institutions and urban landscapes adding a beautiful colorful flowering palette to host plants.

Keywords: *Dendrophthoe falcata,* hemiparasite, Loranthaceae, *haustorium,* urban landscape.

1. Introduction

Parasitic flowering plants can be divided into holoparasites, which lack chlorophyll and depend entirely on the host for carbon and hemiparasites, which retain functional chlorophyll and photosynthetic capacity but tap the host's xylem and occasionally phloem, stream for water, minerals and sometimes additional carbohydrates (Press & Phoenix, 2005). Aerial stem hemiparasites of the mistletoe families Loranthaceae and Santalaceae are the most conspicuous parasitic plants worldwide and have been described as a keystone resource in forest and woodland ecosystems, since their flowers, fruits and dense foliage support pollinators, frugivorous birds and nesting fauna (Watson, 2001; Mathiasen et al., 2008). They play a vital role in biodiversity (Watson, 2001; Shaw, 2004).

In the urban landscape of Patna, the plant offers an interesting example of how biodiversity can quietly transform familiar trees into unexpected visual landmarks, how confusions can be created with a yellow flowering tree with profuse red flowers. Often growing on host trees such as mango **(***Mangifera indica***)**, Mahogany (*swietenia mahagoni*) and other common urban species, its spreading clusters of green foliage and distinctive orange to reddish flowers emerge among the branches, creating striking colourful patches against the otherwise continuous green canopy. Seen from a distance, these flowering clusters can appear almost like ornamental additions to the tree, giving an unplanned aesthetically pleasant roadsides, institutional campuses, gardens and neighborhood greens. For an ordinary urban observer and plant lover, the sight of colorful flowers growing from the branches of a familiar mango tree can evoke curiosity among the plant lovers This moment of questioning is precisely where plant identification surveys become more than inventories of species. They reveal the subtle ecological relationships contained within the everyday urban landscape, encouraging people to look more closely at trees they encounter daily and fostering a sense of curiosity, ecological awareness and appreciation of urban biodiversity.

Within this group, the genus *Dendrophthoe* (Loranthaceae) comprises about 30-31 species distributed across tropical Africa, Asia and Australia, of which seven to eight occur in India (Nickrent et al., 2010). *D. falcata* (L.f.) Ettingsh. is the most common and generalist of these species, native to the Indo-Malesian biogeographic region and reported on more than 300-400 host plant species, making it the mistletoe with the largest recorded global host range (Sampathkumar & Selvaraj, 1981). In the Bihar-Jharkhand region, host-range surveys such as that of Singh and Gupta (2013) in Champaran district of North Bihar have documented *D. falcata* across several tree genera and comparable surveys from adjoining eastern and central Indian states (Joshi & Soni, 2013; Thriveni et al., 2010; Rothe & Maheshwari, 2017) suggested a continuing expansion of the species into managed and urbanised plantations.

Despite its regional prevalence, the specific pattern of occurrence of *D. falcata* within the rapidly urbanising landscape of Patna, the capital of Bihar, remains poorly documented. Urban trees found along street avenues, institutional plantations, riverfront greenery and remnant patches of older vegetation differ markedly from natural forest stands in tree density, host diversity, disturbance regime and management intensity, all of which can alter mistletoe establishment and spread. Understanding where and on which hosts, *D.*

falcata is establishing in Patna is important both for horticultural management, to protect avenue and heritage trees from long-term dieback and for urban biodiversity planning, since the same mistletoe supports pollinators and birds in an otherwise fragmented urban green cover. This study addresses that gap by surveying *D. falcata* occurrence across representative urban landscape typologies in the Danapur block area of Patna and by synthesizing the wider literature on its ecological role services and disservices.

2. Methodology

This was a random study resulted out of curiosity carried out with particular focus on the Danapur block of Patna which includes a mix of urban landscapes as Institutional campuses, riverside tracts along the Ganga, cantonment area plantations, vacant government lands and rapidly urbanizing residential fringes. A random, stratified site-survey approach was adopted. Four broad urban landscape typologies were defined a priori: (i) roadside avenue plantations, (ii) Peri-urban tracts, (iii) Institutional and academic campuses, (iv) vacant lands, and remnant or relict landscape patches retaining older tree cover. Within each ecosystem typology identified occurrence was recorded using a random-walk method along accessible transects and every tree encountered was visually inspected for the presence of *D. falcata* clumps in its canopy. The survey was conducted partly in February, March and in May.

It was a rapid observational and incidental assessment along the different typologies. For each host-parasite association, the following were recorded: host species identity, canopy position of the mistletoe clump, apparent severity of infestation (light, moderate or heavy, based on the proportion of host canopy bearing visible *D. falcata* clumps) and the general vigour and management status of the host tree. Photographic records were taken for each association encountered. A review of published and grey literature was undertaken to compile information on the ecological, ethno-medicinal and phytochemical significance of *D. falcata* and to catalogue the reported advantages and disadvantages of mistletoe presence in managed, agricultural and urban landscapes. Field data were tabulated by landscape typology, host species and infestation severity to identify patterns of host preference and the relative probability of *D. falcata* establishment across the different typologies. Literature-derived advantages and disadvantages were similarly tabulated.

3. Findings

The literature review identified a consistent set of ecological, medicinal and cultural advantages of *D. falcata* alongside recurrent disadvantages associated with host-tree health, safety and urban aesthetics; which is summarised in Table 1. In brief, the species' floral and fruit resources make it a valuable, if unintentional, contributor to pollinator and avian diversity in fragmented urban green cover and its leaf extracts have documented antioxidant, anti-inflammatory and ethno-medicinal properties. Set against these benefits, the literature consistently reports host dieback, reduced canopy vigour, branch-breakage risk and difficulty of eradication once haustorial connections are established within host tissue, particularly given the species' unusually broad host range.

Field surveys in the Danapur block area of Patna recorded active *D. falcata* infestation across 4 of the sampled landscape typologies as vacant lands and remnant landscapes, an institutional campus and government office premises. Table 2 summarises the host plants recorded at each site. On vacant and remnant lands, *D. falcata* was recorded on *Solanum torvum* (Turkey berry//Bhankatiya), indicating opportunistic establishment on less intensively managed shrub and small-tree vegetation. On the institutional campus, infestation was recorded on *Mangifera indica* (mango tree) and in *Swietenia mahagony* (Mahagony tree); despite the presence of the parasite, host growth was actively maintained through routine pruning and care by campus horticulturists. At the DRM Office premises, Danapur, infestation was recorded on ornamental avenue plantings of *Callistemon lanceolatus* (bottlebrush) and *Lagerstroemia indica* (crape myrtle).

Table 2: Reported advantages and disadvantages of *Dendrophthoe falcata* in urban landscapes (literature review)

S. No.	Ecosystem services of ***D. falcata*** in Urban Landscapes	Ecosystem disservices (EDS)/Threats of ***D. falcata*** in Urban Landscapes	Literature Source(s)
1	Provides nectar and fruit resources that support pollinators (sunbirds, flowerpeckers) and frugivorous birds, sustaining urban avifaunal diversity.	Diverts host xylem water and mineral supply through the haustorium, reducing host vigour and causing progressive branch dieback.	Watson, 2001; Davidar, 1983 (advantage); Press & Phoenix, 2005 (disadvantage)
2	Functions as a keystone floral/fruit resource in fragmented urban green spaces where native flowering trees are scarce.	Heavy, long-standing infestation weakens supporting branches, increasing the risk of limb failure along roadside avenues and public spaces.	Watson, 2001 (advantage); Mathiasen et al., 2008 (disadvantage)
3	Source of bioactive compounds; leaf extracts show reported antioxidant and anti-inflammatory activity and the plant has ethno-medicinal use.	Reduces the aesthetic and economic value of avenue, ornamental and fruit-bearing trees, including reported yield loss in mango (*Mangifera indica*).	Patil et al., 2011; Pattanayak & Sunita, 2008 (advantage); Mathiasen et al., 2008 (disadvantage)
4	Adds structural, floral and canopy diversity, indicating continued ecological connectivity between urban and peri-urban green patches.	Extremely broad, generalist host range (reported on 300-400+ species) allows rapid establishment across diverse urban tree taxa once introduced.	Watson, 2001 (advantage); Sampathkumar & Selvaraj, 1981; Khan et al., 2023 (disadvantage)

S. No.	Ecosystem services of *D. falcata* in Urban Landscapes	Ecosystem disservices (EDS)/Threats of *D. falcata* in Urban Landscapes	Literature Source(s)
5	Recognised in traditional Ayurvedic medicine (known regionally as "Vanda"), lending cultural and ethno-botanical value.	Once established, control is difficult; surface removal alone is ineffective because the haustorium regenerates new shoots unless excised well below the point of attachment.	Mathiasen et al., 2008 (advantage and disadvantage)

Table 3: Distribution of occurrence of *Dendrophthoe falcata* recorded in the Danapur block area, Patna.

S. No.	Urban landscape typology	Recorded Host Plant(s)	Observed Infestation Status
1	Vacant lands and remnant landscapes (Anand Bazar,Danapur)	*Solanum torvum* (Turkey berry/Bhankatiya)	Light–moderate; opportunistic establishment on under-managed shrub/tree vegetation, visible due to bright flowers
2	Institutional campus (NIH Patna)	*Mangifera indica* (Mango tree) *Swietenia mahagoni (Mahagony)*	High, observed moderate due to manual removal, host survival maintained through active horticultural pruning and care
3	Government office premises (DRM Office, Danapur)	*Callistemon lanceolatus* (Bottlebrush) *Lagerstroemia indica* (Crape myrtle)	Light–moderate, Detected due to different leave texture.
4	K.V.Danapur	*Cassia siamea*	Light, detected due to flowering , Leaf texture change



Fig 1: *Dendrophthoe falcata* in Danapur Cantonment Area in Patna in the host plant *Solanum torvum*



Fig 2: *Dendrophthoe falcata* in NIH campuses in the host plant *Swietenia mahagoni.*



Fig.3: Infestation of *Dendrophthoe falcata* and *Mangifera indica (NIH Patna Campus), the haustorial attachment*

4. Analysis

Dendrophthoe falcata is locally known by different names across India, including Raghumala in Assamese, Vando in Gujarati, Banda and Banda Patha in Hindi, Ottuchedi in Irula, Badanike and Maduk in Kannada, Bemdram in Konkani, Ittikkanni in Malayalam, Bandgul and Vanda in Marathi, Honey Suckle Mistletoe in English, Vṛkṣādani in Sanskrit, Uchi, Pulluri and Pulluruvi in Tamil, and Jiddu and Yelinga in Telugu. These are known to be parasitic shrub through a parasitic mass of woody tissue called haustorium. In Patna, local Gardeners (Mali) at the DRM Office refer to it as **"Banda,"** while in Mithila region (North Bihar) it is locally known as **"Banjhin or Baanjhi,"** referring to its perceived effect of reducing the productivity of host plants, particularly the commonly observed in **mango trees**, often a problem for Mango orchards as confirmed by local gardeners and residents.

4.1 Identification, Growth Pattern and Establishment

As described by field observers in *Flowers of India*, The plant is a large, much-branched generally reaching 1–3 m in length. The branches are characteristically swollen towards the base and bear a dark-grey bark. The leaves are arranged oppositely along the branches and are relatively thick and coriaceous (leathery), measuring approximately 7–15 cm long and varying considerably in shape. The leaf stalks are about 1 cm long, with a distinct reddish midrib. A haustorium is a specialized root-like or branch-like structure that a parasitic organism or plant uses to penetrate a host and absorb water, nutrients, and organic molecules.



Fig 4: *D. falcata herbarium* (Indian institute of Integrative medicine-CSIR), Parts of Plants for field identification

The flowers arise in stout racemes from the leaf axils and are particularly useful for field identification. The flower buds appear as elongated red tubes, while the mature flower tube is approximately 3–5 cm long and red in colour. The five narrow, greenish to yellowish lobes of the corolla are characteristically upturned. The four to six stamens protrude beyond the flower tube, while the slender green style extends beyond the stamens. A useful field characteristic is the distinctive combination of opposite, thick leathery leaves and conspicuous red tubular flowers, which makes the species readily recognizable when flowering. The species may also exhibit considerable variation in leaf form, and comparison of vegetative and reproductive characters is therefore useful for confirmation. Its persistent attachment and conspicuous branching habit can make an established individual appear as a separate shrub growing within the canopy of its host.

Dendrophthoe falcata seeds are dispersed chiefly by frugivorous birds, whose sticky viscin-coated seeds adhere to host branches after ingestion and regurgitation or defecation (Karunaichamy et al., 1999; Davidar, 1983). Germinating seedlings preferentially establish on sunlit, horizontally oriented branches where bird perching and seed deposition are most frequent, after which the haustorium penetrates host xylem tissue and the mistletoe develops as an increasingly conspicuous, pendulous clump. Because establishment depends on bird activity rather than active seed dispersal by the parasite itself, infestation tends to accumulate gradually over years and is strongly linked to the presence of perching sites and fruiting/flowering resources nearby that attract avian vectors.

4.2 Probability of Hosting Across Landscape Typologies

The field observations suggest that the probability of *D. falcata* establishment varies with the level of active management associated with each landscape typology. Vacant lands and remnant landscapes, which receive minimal horticultural attention, showed infestation on an atypical, less commonly reported host (*Solanum torvum*), suggesting that unmanaged vegetation with limited pruning intervention offers greater opportunity for undetected establishment and gradual spread. Institutional campuses, despite having active horticultural staff (gardener), still showed infestation on mango and mahagony trees; the maintained vigour of the host, sustained through pruning, appears able to offset some but not all of the physiological burden imposed by the parasite. Government office premises, where ornamental species such as bottlebrush and crape myrtle are planted largely for aesthetic value along gardens and walkways, showed infestation on ornamental areas too.

Taken together with *D. falcata's* documented capacity to parasitise several hundred host species across India (Sampathkumar & Selvaraj, 1981; Khan et al., 2023), these typology-wise patterns indicate that no single land-use category in urban Patna is inherently immune to establishment, and that the probability of further spread will increase over time if infestation is left unchecked, given continued bird-mediated dispersal, the abundance of susceptible ornamental and avenue species already in place, and the limited routine canopy inspection typical of many urban and peri-urban plantations.



Fig 5: *D. falcata's* from Pundir (1996), Thriveni et al. (2010).

4.3 Regional Variation in Host Preference

The literature shows that *Dendrophthoe falcata* has a wide but regionally variable host range across India**.** Studies from Gujarat, Karnataka, North Bihar and other regions indicate that the probability of infestation differs among host species and locations. While trees such as *Mangifera indica*, *Ficus religiosa*, *Albizia lebbeck*, *Psidium guajava* and *Bombax ceiba* are repeatedly reported as hosts, their frequency of occurrence varies by region. As indicated in Table 3**,** this suggests that *D. falcata* is a generalist hemiparasite with distinct regional host preferences**,** influenced by host availability, local environmental conditions and host–parasite interactions. Identifying these host plants through literature could help in better management of this hemiparasite in Patna.

Table4: Regional Variations of Host Plants of *D falcata* Across India

Host tree	Scientific name	Literature/source
Neem	*Azadirachta indica*	Reported among Indian host records/reviews
Mango	*Mangifera indica*	Singh & Gupta (2013); review literature (Indian Journal of Life Sciences), Subhashini et al, 2019 (Tropical Plant Research)
Peepal	*Ficus religiosa*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Banyan	*Ficus rumphii*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Guava	*Psidium guajava*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Jamun	*Syzygium cumini/Eugenia jambolana*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Bael	*Aegle marmelos*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Siris	*Albizia lebbeck*	Singh & Gupta (2013); Khan et al. (2023) (Indian Journal of Life Sciences)
Eucalyptus	*Eucalyptus globulus*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Pomelo	*Citrus maxima*	Singh & Gupta (2013) (Indian Journal of Life Sciences)
Babul/Kikar	*Vachellia nilotica*	**Primary host** in Khan et al. (2023) (Pakbs)
Semal	*Bombax ceiba*	**Secondary host** in Khan et al. (2023) (Pakbs)
Flacourtia	*Flacourtia indica*	**Tertiary host** in Khan et al. (2023) (Pakbs)
Fig	*Ficus auriculata*	Khan et al. (2023) (ResearchGate)
Wild fig	*Ficus palmata*	Khan et al. (2023) (ResearchGate)
Mulberry	*Morus* sp.	Khan et al. (2023) (ResearchGate)
Mahua	*Madhuca longifolia*	Khan et al. (2023) (ResearchGate)
Carissa	*Carissa opaca*	Khan et al. (2023) (ResearchGate)
Poplar	*Populus nigra*	Khan et al. (2023) (ResearchGate)
Anjan	*Hardwickia binata*	Balachandran et al, 2025 (Species)
Morinda	*Morinda coreia*	Balachandran et al, 2025 (Species)
Poison nut/Kuchla	*Strychnos nux-vomica*	Balachandran et al, 2025 (Species)

4.4. Medicinal and Traditional Uses

Dendrophthoe falcata (L.f.) Ettingsh., locally known as Banda/Vanda and referred to as Vṛkṣādani in Ayurvedic literature, has a long history of ethnomedicinal use in India. Different plant parts, including leaves, stems, bark, flowers and the whole plant, have traditionally been used for wound healing, rheumatic complaints, asthma, menstrual disorders, leucorrhoea, bone fractures, respiratory ailments and certain skin conditions (Pattanayak et al., 2008; Kong et al., 2023). Traditional systems also describe the plant as having cooling, astringent, diuretic and aphrodisiac properties (Pattanayak & Sunita, 2008; Kong et al., 2023). Some ethnomedicinal records mention its use for pulmonary tuberculosis and other ailments (Kong et al., 2023). These records only represent traditional knowledge systems and though clinical validation still required. As confirmed by local filed experts (Vaidyanath Jha 2026) of Bihar till a few decades back its wood was used for heating oyster shells for production of lime in country side. That was on account of the fact that intense heat required for formation of lime was obtained through this process.

4.5 Spread Management

The literature is consistent in noting the fact that mechanical removal of visible mistletoe clumps alone is insufficient, as the haustorium persists within host tissue and regenerates new aerial shoots unless the infected branch is excised well below the point of attachment (December to May) (Mathiasen et al., 2008). The field landscape managers trained in horticultural practices in NIH campus and Gardeners DRM Office Danapur has also assured that they monitor the spread in weekly basis in all trees in the campus. It is also observed that the growth of this hemi parasite is more in NIH campus being Mango as the host plant and DRM office is limited and confined. For Patna, this implies a coordinated role for the municipal horticulture and forestry authorities, campus and institutional garden departments and custodians of government office premises a periodic canopy inspection schedules, particularly ahead of the mistletoe's fruiting season when bird-mediated dispersal peaks and in maintaining simple infestation records comparable to those compiled in this survey. Since *D. falcata* also carries genuine ecological value for pollinators and birds, governance responses should favour a managed-retention approach in non-critical remnant and vacant-land patches, reserving active pruning and removal for avenue trees, ornamental plantings and heritage or high-value specimens where host health and public safety are the priority.

5. Recommendations for Spread Control in Patna

Based on the field observations and literature review, the following measures are recommended for the context of Patna: (i) institute periodic, seasonal canopy surveys of avenue trees, institutional campuses and government office plantations, with particular attention before the *D. falcata* fruiting period; (ii) prune and excise infected branches well below the haustorial attachment point rather than removing only the visible aerial clump and dispose of pruned material to prevent re-establishment; (iii) avoid large-scale monoculture avenue planting of known highly susceptible ornamental species such as mango, bottlebrush and crape myrtle without a parallel monitoring protocol; (iv) maintain a simple, shared infestation register across the concerned departments to track spread over time; (v) retain, rather than eradicate, light infestations on non-critical vegetation in vacant lands and remnant landscape patches, in recognition of the ecological value *D. falcata* provides to pollinators and birds; and (vi) build basic public and horticultural-staff awareness of the difference between light infestation, which can often be left under observation and heavy infestation, which requires prompt pruning intervention.

6. Conclusion

The study depicts that *Dendrophthoe falcata*, the most widespread and generalist mistletoe of the Indian subcontinent, is actively established within the urban landscape of Patna, occurring on host plants as varied as *Solanum torvum* in vacant and remnant lands, *Mangifera indica*, *Swietenia mahagony* and *Cassia siamea* in institutional campuses and ornamental *Callistemon lanceolatus* and *Lagerstroemia indica* in government office premises. The literature review confirms that the species carries genuine ecological and ethno-medicinal value,

chiefly through the floral and fruit resources it provides to pollinators and frugivorous birds, but that these benefits are set against real risks to host-tree vigor, canopy safety and the aesthetic and economic value of avenue and ornamental plantings. Given the species' unusually broad host range (Table 3) and these host plants are native to Bihar, and its bird-mediated mode of spread, unchecked infestation is likely to expand further across Patna's diverse urban tree stock over time. A balanced, governance-led response, combining periodic canopy monitoring, proper below-attachment pruning of heavily infected specimens and managed retention of light infestations in non-critical green patches, is recommended to reconcile the biodiversity value of *D. falcata* with the need to protect the health and safety of Patna's urban and institutional tree cover. This work has been done in very confined area with rapid assessment but a wider assessment is required. Rather than viewing mistletoe only as a harmful parasite, it may also be appreciated as an indicator of bird-mediated ecological interactions and associated ecosystem services. Its vivid flowers and colours add aesthetic value to urban trees, creating an element of surprise and curiosity that invites people to look closer and discover the hidden biodiversity within everyday landscapes. Future work should extend this survey across all urban landscapes and additional blocks of Patna district to build a more complete, city-wide picture of *D. falcata* distribution and host preference.

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अन्त कथन

हमारी पत्रिका के इस दूसरे अंक का प्रकाशन गांधी जयंती, वन्यजीव सप्ताह और राष्ट्रीय डॉल्फिन दिवस के अवसरों के साथ हुआ है।

महात्मा गाँधी का जीवन प्रकृति के प्रति संवेदना और अहिंसा के पालन का परम अनुकरणीय उदाहरण है। अहिंसा में निहित उदात्त भावना हमारी जैव विविधता विरासत के संरक्षण के लिए भी प्रेरक है। सभी मानव–जनित भौतिक विकास की क्रिया–कलापों में प्राकृतिक जैव विविधता के प्रति अहिंसा के सिद्धांत का व्यवहारिक पालन करना सतत विकास की अवधारणा को वास्तव में प्रभावी बनाने के लिए मौलिक है।

वन्यजीवों की विविधता समग्र जैव–विविधता और प्रकृति संरक्षण के लिए स्वाभाविक रूप से महत्वपूर्ण हैं, साथ ही कृषि, पशुधन और मत्स्यिकी में जैव विविधता भी वन्य–परिवेश की विविधता – यानि पारितंत्रों, अधिवासों, वनस्पतियों और जीव–जंतुओं के साथ महत्वपूर्ण संबंध साझा करती है।

इस अंक की सामग्री में जैव विविधता के विभिन्न पहलुओं की चर्चा है। हमें उम्मीद है कि ये रोचक होंगे और जैव विविधता संरक्षण के संदर्भ में गहन परिचर्चा को प्रोत्साहित करेंगे।

भारत ज्योति

अध्यक्ष, बिहार राज्य जैव विविधता पर्षद्

Afterword

Publication of this 2nd issue of our journal has coincided with the occasions of Gandhi Jayanti, Wildlife Week and National Dolphin Day.

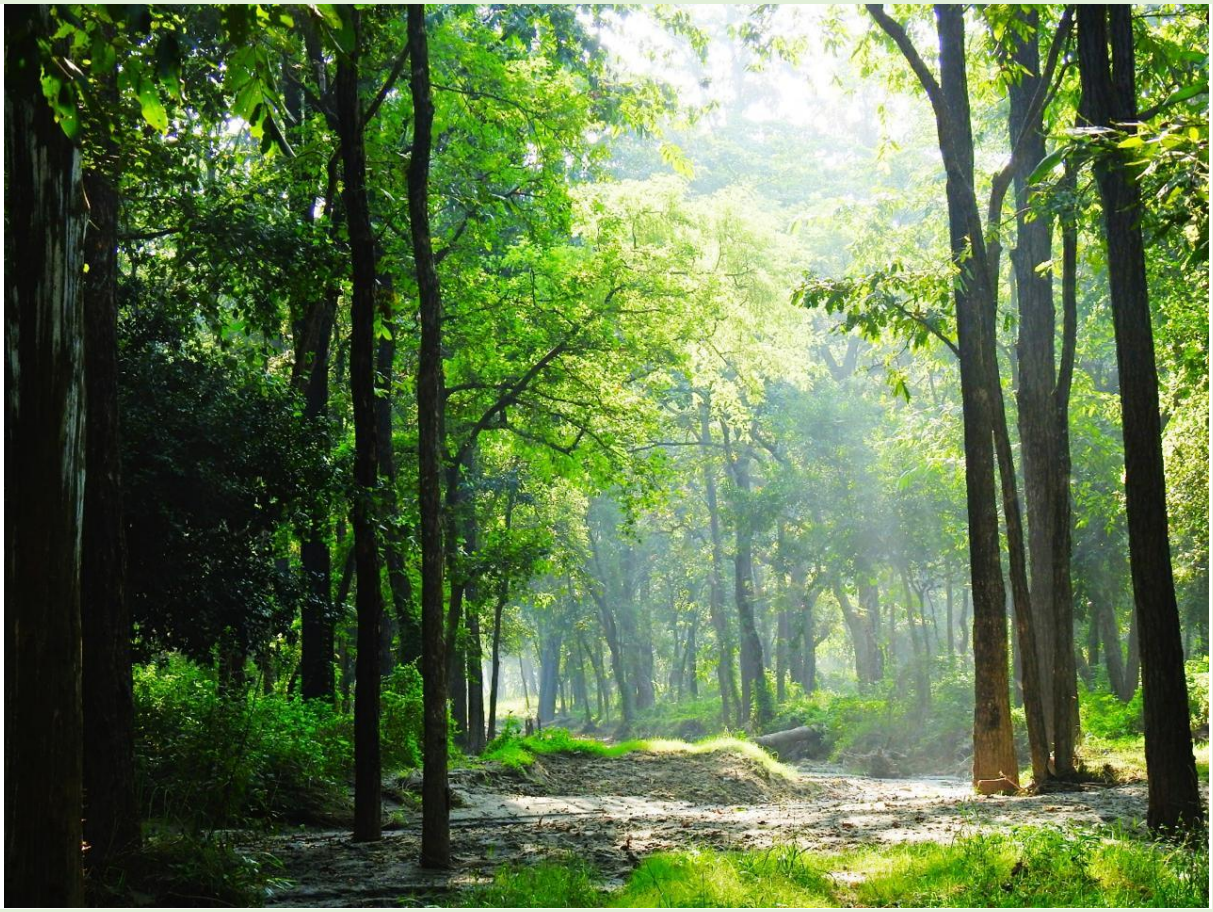
Gandhiji's life exemplified empathy towards nature and practice of non-violence. The noble ideas behind practice of non-violence also inspire conservation of our biodiversity heritage. Practicing non-violence towards natural biodiversity into all human led development activities is fundamental in making the concept of sustainable development truly effective.

The diversity of wildlife is inherently significant for overall biodiversity and nature conservation. The conservation of biodiversity in agriculture, animal husbandry and fishery also share critical connections with the diversity of wildlife – the ecosystems, habitats, flora and fauna. The contents of this issue relate with varied aspects of biodiversity. We expect these to be interesting, and may encourage deeper conversation in the context of biodiversity conservation

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Bharat Jyoti

Chairperson, Bihar State Biodiversity Board



Guidelines for Submission of Articles:

Articles on subjects of biodiversity preferably with content having focus on or related to Bihar state, as short communication, review or research papers, are invited from the researchers, faculty members, scientists, and officers of our Knowledge Partner Institutions/Organizations and sister organizations and other associates of the BSBB.

The manuscripts are to be sent ONLY by e-mail (bdbihar@bihar.gov.in) by the corresponding author both in pdf and word file in the Times New Roaman font, font size 12, line spacing - 1.5, with source of photos mentioned, and secondary data and references (as - Atluri, J.B., Rao, S.P. & Reddi, C.S. (2000). Pollination ecology of *Helicteres isora Linn*. Current Science, 78(6), 713–718.) in case of review/research papers given in the manuscript.

No acknowledgement will be sent for the manuscript submitted and no fees will be charged against any article published in the BSBB Journal.

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जैव विविधता बिहार Biodiversity Bihar

वर्ष–01, अंक 02, सितंबर 2026
Vol. 1, Issue No.2, September 2026

बिहार राज्य जैव विविधता पर्षद्

(जैव विविधता अधिनियम–2002 अंतर्गत वैधानिक निकाय)