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26 October 2020 | Vol. 12 | No. 14 | Pages: 17014–17023
DOI: 10.11609/jott.4964.12.14.17014-17023
Contribution to the macromycetes of West Bengal, India: 63–68

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Abstract: West Bengal, a significant landmass of eastern India with its varied topography, edaphic, and climatic conditions facilitates diversified forest types and conducive microhabitats for a wide array of macro-fungal wealth and the members of Aphyllophorales in particular. Detailed macro-microscopic characterizations and chemical reactions were performed to systematically identify the specimens using standard key and literatures. Six members of Aphyllophorales collected from different parts of West Bengal, India and four species belonging to the family Polyporaceae [Hexagonia tenuis (Fr.) Fr., Polyporus arcularius (Batsch) Fr., P. tricholoma Mont. and Lenzites elegans (Spreng.) Pat.] were identified, and a single species was identified under Meripiliaceae [Physisporinus lineatus (Pers.) F. Wu, Jia J. Chen & Y.C. Dai] and Meruliaceae [Bjerkandera fumosa (Pers.) P. Karst.]. The detailed description along with field and herbarium photographs, macro-morphology, and microscopic features of six species are provided in this article.

Keywords: Aphyllophorales, Basidiomycota, hymenophore, taxonomy, West Bengal.

During the macrofungal survey in different parts of West Bengal with various forest types (viz., mountain temperate forest, tropical mixed evergreen forests of the foothills, the deciduous forests of the plateau fringe, and the tidal forests of Sundarbans), edaphic and climatic conditions (average annual rainfall 175cm and humidity 71%), six species of the order Aphyllophorales (Basidiomycota) were identified. In continuation to our earlier publications (Acharya et al. 2017; Tarafder et al. 2017; Bera et al. 2018, Saha et al. 2018a, b, Das et al. 2020) the species are being contributed to the Macromycetes of West Bengal, with more detailed descriptions with necessary remarks.

Material and Methods

The macro-fungal specimens were collected during monsoon and post monsoon season from June to November (2000–2018) from different parts of West Bengal, India. Field study of the collected specimens like date and collection place, habit, habitat, types of fruiting body and their attachment to the substratum, pileus upper surface, presence or absence of hairs,
hymenophore surface, types of hymenophore, margin, presence or absence of stipe and stipe attachments were noted carefully in the field book. Colour photographs of the upper surface of the pileus, hymenophore region, context and tube layers were taken for future references. The fruiting bodies were carefully separated with the help of scalpel and chisel from the substratum. Then each collection was wrapped with tissue papers and isolated in a box to avoid contamination. The collected specimens were dried in a hot air drier prior to microscopic study. Microscopic characters were noted by crushing and making transverse sections of these dried materials by mounting and staining in 10% KOH, Congo red and Melzer’s reagent and observing it under a microscope. Amyloidity/non-amylodity/dextrinoidity of the microscopic features were observed using Melzer’s reagent. Microscopic characters like hyphal system, presence or absence of clamp connections, basidia, basidiospores, cystidia, cystidioles were noticed under Carl Zeiss AX10 Imager A1 phase contrast microscope for systematically identifying the specimens. Standard keys and published literatures have been referred to in order to compare our specimens and identify them correctly (Roy et al. 1996; Sharma 2012). For colour terms and codes of the specimens, the Methuen Handbook of Colour was used (Kornerup et al. 1978). To calculate the dimensions of basidiospores, 30 measurements were taken from each specimen. The Q value is denoted by Length/breadth ratio. The measurement of mean Q value (Q sample. The Q value is denoted by Length/breadth ratio. Basidiospores (up to 13 µm long) (Sharma 2012). 

**Results and Discussions**

**Hexagonia tenuis** (Fr.) Fr.

Epicr. syst. mycol. (Upsaliae): 498 (1838) [1836-1838]

(Image 2a, Figure 1)

Basidiocarp annual, pileate, sessile. Pileus semicircular 25–41 mm broad and wide 1–2 mm thick near the base, thin, flexible. Upper surface glabrous with concentric zones, brown (7E5, 7E7); greyish violet (17D6) in KOH when fresh and blackening in KOH when dry. Margin white (1A1), thin, entire, sometimes lobed. Pore surface light brown (7D4) in colour, pore hexagonal, 1 per mm. Tubes light brown (7D4), 1mm deep. Hyphal peg absent. Context 1mm thick, brown (7E5).

Hyphal system trimitic; generative hyphae clamped, 2.8–3.58 µm wide, hyaline, thin walled; skeletal hyphae 3.58–5.37 µm wide, hyaline, thick-walled, branched; binding hyphae 1.79–3.58 µm wide, hyaline. Cystidia absent. Basidia clavate, 29.52–35.8 × 7.1–10.74 µm in diameter, hyaline, thin walled, 4-sterigmate. Basidioles clavate, 20.41–28.64 × 7.16–8.59 µm in diameter, hyaline, thin walled. Basidiospores cylindrical, (13.60–14.32–16.38–18.26–22.19) × 3.58–3.77–4.29 µm in diameter, Q=3.42–5.63, Q m=4.33, hyaline, thin walled, non-dextrinoid.

**Habit and habitat:** Solitary to gregarious, grown on dead wood of *Mangifera indica* L.

**Specimen examined:** CUH AM559, 27.vi.2017, 22.527⁰N & 88.362⁰E, elevation 13m, Ballygunge Science College, Kolkata, West Bengal, India, coll. R. Saha & K. Acharya.

**Geographical distribution:** India (Leelavathy et al. 2000; Sharma 2012), eastern Africa (Ryvarden & Johansen 1980), and Malawi (Morris et al. 1990).

**Remarks:** The present specimen is characterized by its sessile basidiocarp, semicircular, glabrous pileus with concentric zones; greyish violet (17D6) in KOH when fresh and blackening in KOH when dry; hexagonal shaped pores, 1 per mm; trimitic type of hyphal system; clamped generative hyphae; basidiospores measuring 13.60–22.19 × 3.58–4.29 µm in diameter with mean Q value of 4.33.

The description of our collection matches with the description reported from Uttarakhand (Sharma 2012) and East Africa. The specimen from Kerala (Leelavathy et al. 2000) differs from the present collection with regard to slightly smaller basidiospores (9–15.5 × 3–4.5 µm vs 13.60–22.19 × 3.58–4.29 µm).

Among morphologically closely related species, *Hexagonia hirta* (P. Beauv.) Fr. differs by the presence of long, dark stiff, erect or branched hairs; *Hexagonia papyracea* Berk. differs by the presence of smaller basidiospores (up to 13µm long) (Sharma 2012).

**Polyporus arcularius** (Batsch) Fr.

Syst. mycol. (Lundae) 1: 342 (1821)

(Image 2b, Figure 2)

Basidiocarp pileate, centrally stipitate. Pileus round 13–14 mm in diameter, funnel shaped, depressed at disc. Upper surface light brown (6D4) when young and dark brown (9F4) at maturity. Margin thin, ciliated, inrolled when dry. Pore surface greyish-orange (5B3)
Image 1. Herbarium photographs of the specimens: a—Hexagonia tenuis | b—Polyporus arcularius | c—Polyporus tricholoma | d—Lenzites elegans | e—Physisorinus lineatus | f—Bjerkandera fumosa.
when young, orange gray (5B2) at maturity, pores 1–2 per mm, angular to pentagonal. Pore tubes greyish-orange (5B3) to orange grey (5B2), tubes up to 1mm deep. Context 0.5–1 mm, thin, greyish-orange (5B3) to orange grey (5B2). Stipe straight, cylindrical, broad towards base, 24–44 × 14–20 mm in diameter, slightly pubescent towards base, brownish-orange (5C4) when young, greyish brown (8E3) at maturity, base strigose, solid.

Hyphal system dimitic; in context region generative hyphae clamped, branched, mostly thin-walled, some with thick-walled, 3.5–6.6 µm wide, hyaline; gloeopherous hyphae 3.58–7.16 µm wide with clamp connection. On the pileus upper surface generative hyphae much wider, swelled, 4.9–11.6 µm wide, thin to thick walled; some thin to thick walled, intertwined generative hyphae also present, usually 7.16–14.32 µm in diameter. Binding hyphae hyaline, thick-walled to solid, dendritic, branched, 3.5–6.5 µm wide. Some thin to thick-walled, interlocking generative hyphae present at brownish base of stipe, 4.99–8.33 µm wide. Cystidiole 12.53–14.32 × 3.58–5.37 µm in diameter, hyaline, thin-walled. Basidia 4-sterigmate, clavate, 12.5–17.9 × 3.5–4.29 µm in diameter, hyaline, thin walled. Basidiospores cylindrical with apiculate, guttulate, (5–)6.4–7.88 × (1.7–)2.5–2.9–3.58 µm in diameter, Q=1.67–4, Q_m=2.48, hyaline, thin walled.

**Habit and habitat:** Solitary to gregarious, grown on dead wood of angiosperm.

**Specimen examined:** CUH AM560, 5.vi.2017, 26.885⁰N & 88.182⁰E, elevation 1650.22m, Mirik, Darjeeling District, West Bengal, India, coll. S. Paloi & E. Tarafder. CUH AM555, 17.vii.2017, 26.192⁰N & 89.273⁰E, elevation 47m, Debhibari, New Coochbehar District, West Bengal, India, coll. R. Saha & K. Acharya.

**Geographical distribution:** India (Roy et al. 1996; Leelavathy et al. 2000), East Africa (Ryvarden & Johansen 1980), Malaya (Corner 1984), Austria (Krüger et al. 2004), USA (Krüger et al. 2004) and China (Krüger et al. 2004).
**Remarks:** *Polyporus arcularius* (Batsch) Fr. possesses characteristic features like centrally stipitate basidiocarp; thin, ciliated margin; pores 1–2 per mm, angular to pentagonal; slightly pubescent stipe towards the base; dimitic type of hyphal system; clamped generative hyphae; dendritic type of binding hyphae; hyaline, cylindrical, apiculate, guttulate basidiospores measuring 5–7.88 × 1.7–3.58 µm in diameter with mean Q value of 2.48.

The description of our collection agreeably matches with the previous report from Malaya and Bardwan (Roy et al. 1996). The specimen reported from eastern Africa and Uttarakhand (Sharma 2012) differs by having larger spores (7–11 × 2–3.5 µm, Ryvarden & Johansen (1980) and 7–9 × 2–3 µm, Sharma (2012)) that may be attributed to the reason of climatic and geographical variations. The specimen reported from Kerala (Leelavathy et al. 2000) varies a bit from the present collection with regard to the absence of cystidiole.

Among macro-microscopically alike species of *Polyporus arcularius* (Batsch) Fr., *P. umbellatus* (Pers.) Fr. differs by having basidiocarp with several pilei from a common base; *Polyporus grammocephalus* Berk. differs by having laterally stipitate basidiocarp; and *Polyporus tricholoma* Mont. differs by having 6–8 pores per mm (Sharma 2012).

**Polyporus tricholoma** Mont.

*Ann. Sci. Nat., Bot., sér. 2* 8: 365 (1837)

(figure 2c, figure 3)

Basidiocarp annual, centrally stipitate. Pileus 5–11 mm in diameter, upper surface reddish brown (9D4), smooth, glabrous, centrally depressed. Margin thin, ciliated. Pore surface whitish (1A1), pores round to angular, 5–7 per mm. Context thin, 1 mm thick, whitish (1A1). Tubes whitish (1A1), 1mm thick. Stipe 4–10 mm long and 1–2 mm thick, pale reddish brown (8D4), glabrous, solid and cylindrical.

Hyphal system dimitic; in the context generative hyphae clamped, thin walled, 3.58–5.73 µm wide hyaline, branched, sometimes thick walled, 6.44–7.88 µm wide. On the pileus surface generative hyphae thin to thick walled, 6.44–7.88 µm wide, hyaline, branched. Some strongly interwoven to skin like appearance; gloeopherous hyphae 3.58–5.37 µm wide, hyaline; binding hyphae dendritic, thick walled, 3.58–5.37 µm wide, branched, solid, hyaline, septate, some are gradually swelled, 7.16–9.67 µm wide. Basidia not observed. Basidiospores cylindrical, 5.01–6.57–7.16 × 1.79–2.98–3.58 µm in diameter, Q=1.5–3, Q_m=2.29, hyaline, thin walled.

**Habit and habitat:** Solitary to gregarious, grown on dead wood of angiosperm.

**Specimen examined:** CUH AM591, 15.x.2017, 26.684°N & 88.350°E, 124.57m, Sukna, Siliguri District, West Bengal, India, coll. K. Acharya, R. Saha & A. Roy.

**Geographical distribution:** India (Roy et al. 1996; Leelavathy et al. 2000), Brazil (Núñez et al. 1995), eastern Africa (Ryvarden & Johansen 1980), Costa Rica (Krüger et al. 2004), Mexico (Krüger et al. 2004), and USA (Krüger et al. 2004).

**Remarks:** The present specimen is characterized by its centrally stipitate basidiocarp; ciliated margin; 5–7 per mm pores; dimitic hyphal system, clamped generative hyphae and dendritic type of binding hyphae; basidiospores measuring 5.01–7.16 × 1.79–3.58 µm diam. with mean Q value of 2.29. Our present specimen satisfactorily matches with the earlier report of Burdwan (Roy et al. 1996), Uttarakhand (Sharma 2012), Brazil and East Africa. The species reported from Kerala (Leelavathy et al. 2000), as described, slightly differs from our collection by having a bit larger basidiospores.
Contribution to the macromycetes of West Bengal: 63–68.

Saha et al.

Journal of Threatened Taxa

Image 2. Field photographs of the basidiocarp: a—Hexagonia tenuis | b—Polyporus arcularius | c—Polyporus tricholoma | d—Lenzites elegans | e—Physisporinus lineatus | f—Bjerkandera fumosa. Bars = 10mm. © Rituparna Saha.
(7.5–8.7 × 3–3.7 µm vs 5.01–7.16 × 1.79–3.58 µm).

Among macro-microscopically closely related species, *Polyporus umbellatus* (Pers.) Fr. differs by having basidiocarp with several pilei from a common base; *Polyporus grammoecephalus* Berk. differs by having laterally stipitate basidiocarp; and *Polyporus arcularius* (Batsch) Fr. differs by having 1–2 pores per mm (Sharma 2012).

*Lenzites elegans* (Spreng.) Pat.

Essai Tax. Hyménomyc. (Lons-le-Saunier): 89 (1900) (Image 2d, Figure 4)

Fruit body annual, sub-stipitate, laterally attached, 20–50 × 21–25 mm in diameter, 2–6 mm thick towards base, hard, glabrous. Upper surface of pileus orange white (6A2) with dark coloured violet brown (10E4, 10F4) concentric zonations. Margin grey (1D1), sulcate, thin. Hymenophore orange white (6A2), hymenophore irpicoid to daedaloid, partly lamellate, lamellae 3–4 per mm, 1–2 mm thick, orange white (6A2). Context single layered, white (1A1), 1–5 mm thick towards base.

Hyphal system trimitic; generative hyphae clamped at septa, 2.51–3.58 µm wide, thin, hyaline walled; skeletal hyphae solid, thick-walled, 3.58–7.16 µm wide, hyaline; binding hyphae branched, hyaline, solid, septate, 1.43–3.58 µm wide. Cystidia absent. Basidia not observed. Basidiocarp measuring 4.65–7.52 × 1.79–2.97–3.58 µm diam. with mean Q value of 2.23.

Habit and habitat: Solitary to grerarious, grown on dead wood of *Shorea robusta* C.F. Gaertn.

Specimen examined: CUH AMS93, 15.vii.2017, 26.32⁰N & 89.32⁰E, 115m, Damanpur kathgola, Alipurduar District, West Bengal, India, coll. K. Acharya, R. Saha & A. Roy.

Geographical distribution: India (Sharma 2012), eastern Africa (Ryvarden & Johansen 1980), and North Carolina (Grand 2011).

Remarks: *Lenzites elegans* (Spreng.) Pat. is characterized by its lateral stipe; daedaloid to lamellate hymenophore; single layered white context, trimitic type of hyphal system; basidiocarp measuring 4.65–7.52 × 1.79–3.58 µm diam. with mean Q value of 2.23.

In the Indian context, the present taxon was previously reported from Uttarakhand (Dehra Dun). Our collection mostly matches with the specimens reported from Dehra Dun (Sharma 2012) except having slight variations in basidiocarp size. The present specimen is smaller in size with respect to the specimen of Dehra Dun i.e., 100–200 mm wide and 10–30 mm thick (Sharma 2012) that may be attributed due to the reason of climatic and geographical variations. The collection, however, reported from eastern Africa (Ryvarden & Johansen 1980) and North Carolina (Grand 2011) matches with the description of our collected specimen.

Among macro-microscopically similar taxa, *Lenzites betulinus* (L.) Fr. differs by the presence of finely hirsute and concentrically zonate pileus surface; and *Lenzites stereoides* (Fr.) Ryvarden differs by the presence of whitish to wood coloured with pinkish tint basidiocarp and spiny to toothed hymenophore; and *Lenzites acutus* Berk. differs by having 3–6 lamellae per cm (Sharma 2012).

*Physisporinus lineatus* (Pers.) F. Wu, Jia J. Chen & Y.C. Dai

Mycologia 109(5): 760 (2017) (Image 2e, Figure 5)

Basidiocarp annual, pileate, sessile. Pileus dimidiate, 23–31 × 15–20 mm in diam., 1–6 mm thick at base. Pileus upper surface glabrous, greyish orange (5B6) to brownish-orange (7C7) towards base and with brownish-orange (6C7) concentric zones. Margin entire, thin,
Contribution to the macromycetes of West Bengal: 63–68.

Saha et al.

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 October 2020 | 12(14): 17014–17023

Figure 5. *Physisporinus lineatus*: a—basidia | b—generative hyphae | c—apically encrusted cystidia | d—strongly encrusted cystidia | e—pseudo-parenchymatous cells | f—cystidioles | g—acanthophyces | h—basidiospores. Bars = 5µm. Drawing by Rituparna Saha.

decurved on drying, greyish-orange (6B3). Pore surface greyish-orange (6B3), pores circular to angular, 7–10 per mm. Context up to 1mm thick, greyish-orange (6B3) in colour. Tubes 1–2 mm deep, not stratified, concolorous with the context.

Hyphal system monomitic; generative hyphae 3.58–7.88 µm wide, simple septate, hyaline, solid, thin to thick-walled. Cystidia are of two types— one is apically encrusted club shaped cystidia with hyaline, thick- walled, 14.68–21.48 × 4.29–8.95 µm in diameter, apical part wide and basal part tube like, and the other is strongly encrusted cystidia with highly thick-walled, solid, 6.04–11.09 µm wide, embedded in the trama and sometimes partly projecting into the hymenial region. Cystidioles mucronate, tips pointed, 10.74–26.85 × 3.58–7.16 µm in diameter, hyaline. Acanthophyces thick walled, 5.37–8.95 µm wide, hyaline, solid. Pseudo-parenchymatous cell present just below the context region; cells globose to subglobose, thin-walled, 7.16–11.09 × 6.44–7.52 µm in diameter, hyaline. Basidia short, barrel shape, 7.88–14.32 × 5.37–7.88 µm in diameter, hyaline, 4-sterigmate, sterigmata short. Basidiospores thin-walled, globose to subglobose, often with one oil droplet, 3.94–4.58–5.37(–6.44) × 3.58–4.03–5.01 µm in diameter, Q=1–1.27, Q_m=1.13, hyaline, (−) ve in Melzer’s reagent.

**Habit and habitat:** Solitary to gregarious, grown on dead wood of angiosperm.

**Specimen examined:** CUH AM604, 19.ix.2017, 26.28⁰N & 88.63⁰E, 137m, Targhera, Jalpaiguri District, West Bengal, India, coll. R. Saha, K. Acharya & A. Roy.

**Geographical distribution:** India (Leelavathy et al. 2000; Sharma 2012), eastern Africa (Ryvarden & Johansen 1980) and Europe (Ryvarden & Gilbertson 1994).

**Remarks:** *Physisporinus lineatus* (Pers.) F. Wu, Jia J. Chen & Y.C. Dai possesses characteristic features of an annual habit; sessile basidiocarp coloured greyish-orange (5B6) to brownish-orange (7C7) towards base and with brownish-orange (6C7) concentric zonations; pores 7–10 per mm; monomitic type of hyphal system; simple septate generative hyphae; two types of cystidia—one being apically encrusted club shaped, apical part wide and basal part tube like, 14.68–21.48 × 4.29–8.95 µm in diameter and the other being strongly encrusted, highly thick-walled; mucronate cystidioles; thick-walled acanthophyces; and thin-walled, globose to sub-globose basidiospores measuring 3.94–6.44 × 3.58–5.01 µm diam. with mean Q value of 1.13.

Our collection appropriately matches with the previous reports of Uttarakhand (Sharma 2012), Kerala (Leelavathy et al. 2000) and eastern Africa (Ryvarden & Johansen 1980). The specimen reported from Europe bears most resemblances with our collection except for having a larger basidiocarp.

Among the macro and micro-morphologically closely related species, *Physisporinus vitreus* (Pers.) P. Karst. differs from *P. lineatus* (Pers.) F. Wu, Jia J. Chen & Y.C. Dai due to absence of cystidia (Sharma 2012).

**Bjerkandera fumosa** (Pers.) P. Karst.

Meddn Soc. Fauna Flora Fenn. 5: 38 (1879)

*Basidiocarp annual, effused reflexed, sessile, broadly attached to the substratum. Pileus dimidiate, 46–55 × 29–46 mm in diameter and 2–17 mm thick towards base. Upper surface white (1A1) to purplish grey (13D2), glabrous, azonate, irregular. Margin concolourous, 1–2 mm thick. Pore surface grey (7B1) to greyish red (7B3); pores 2–6 per mm, circular to angular towards margin and radially elongate from centre to base. Context
double layered, upper layer whitish and lower layer greyish orange (6B3) near the base, 3–14 mm thick towards base. Tubes 1–3 mm deep, grey (7B1).

Hyphal system monomitic; generative hyphae 3.22–7.16 µm wide, hyaline in water and KOH, thin to thick walled, branched, clamped at septa. Cystidia absent.

Basidia clavate, 4-sterigmate, 14.32–25.06 × 5.37–7.16 µm in diameter, hyaline, thin walled. Basidiospores 6.5 × 2–3.5 µm and 5–5.5 × 2–3.5 µm respectively. The description reported from Russia and Europe, however, matches well with the description of our collected specimen.

Among macro-microscopically closely related taxa, *Bjerkandera adusta* (Willd.) P. Karst. differs by having thinner context (up to 6mm) and a greyish-black zone between the context and tube layer which is concolorous with the tube layer (Sharma 2012).

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– Nor Nasibah Mohd Jamil, Husni Ibrahim, Haniza Hanim Mohd Zain & Nur Hidayat Che Musa, Pp. 16954–16961

Evaluating performance of four species distribution models using Blue-tailed Green Darter Anax guttatus (Insecta: Odonata) as model organism from the Gangetic riparian zone
– Kritish De, S. Zeeshan Ali, Niladri Dasgupta, Virendra Prasad Uniyal, Jeyaraj Antony Johnson & Syed Ainul Hussain, Pp. 16962–16970

Butterfly species richness and diversity in rural and urban areas of Sirajganj, Bangladesh
– Sheik Muhammad Shaburul Imam, Amit Kumer Neogi, M. Ziaur Rahman & M. Sabbir Hasan, Pp. 16971–16978

Chroococcalean blue green algae from the paddy fields of Satara District, Maharashtra, India
– Sharada Jagannath Ghadage & Vaneeta Chandrashekhar Karande, Pp. 16979–16992

A rare camera trap record of the Hispid Hare Caprolagus hispidus from Dudhwa Tiger Reserve, Terai Arc Landscape, India
– Sankarshan Rastogi, Ram Kumar Raj & Bridesh Kumar Chauhan, Pp. 17024–17027

First distributional record of the Lesser Adjutant Leptoptilos javanicus Horsfield, 1821 (Ciconiiformes: Ciconiidae) from Sindhuli District, Nepal
– Badri Baral, Sudeep Bhandari, Saroj Koirala, Parashuram Bhandari, Ganesh Magar, Dipak Raj Basnet, Jeevan Rai & Hem Sagar Baral, Pp. 17028–17031

First record of African Sailfin Flying Fish Parexocoetus mento (Valenciennes, 1847) (Beloniformes: Exocoetidae), from the waters off Andaman Islands, India
– Y. Gladston, S.M. Ajina, J. Praveenraj, R. Kiruba-Sankar, K.K. Bineesh & S. Dam Roy, Pp. 17032–17035

A first distribution record of the Indian Peacock Softshell Turtle Nilssonia hurum (Gray, 1830) (Reptilia: Testudines: Trionychidae) from Mizoram, India
– S. Dam Roy, Pp. 17032–17035

First distributional record of the Lesser Adjutant Leptoptilos javanicus Horsfield, 1821 (Ciconiiformes: Ciconiidae) from Sindhuli District, Nepal
– Badri Baral, Sudeep Bhandari, Saroj Koirala, Parashuram Bhandari, Ganesh Magar, Dipak Raj Basnet, Jeevan Rai & Hem Sagar Baral, Pp. 17028–17031

Notes
A frog that eats foam: predation on the nest of Polypedates sp. (Rhacophoridae) by Euphylctis sp. (Dicroglossidae)
– Pranoy Kishore Borah, Avrajal Ghosh, Bikash Sahoo & Aniruddha Datta-Roy, Pp. 17044–17047

New distribution record of two endemic plant species, Euphorbia kadapensis Sarojin. & R.R.V. Raju (Euphorbiaceae) and Lepidagathis keralensis Madhus. & N.P. Singh (Acanthaceae), for Karnataka, India
– P. Raja, N. Dhatchanamoorthy, S. Soosairaj & P. Jansirani, Pp. 17045–17048

Addendum
Erratum and addenda to the article ‘A history of primatology in India’
– Mewa Singh, Mrudula Singh, Honnavalli N. Kumara, Dilip Chetry & Santanu Mahato, Pp. 17060–17062