UDC 595.768.23:582.232:582.263:591.557(477.23) DOI: 10.36016/KhESG-2020-28-2-3

© 2020 N. N. YUNAKOV, D. S. KHRAPOV

DISCOVERY OF EPIZOIC ALGAE ON SEMIAQUATIC WEEVILS *BAGOUS TUBULUS* CALDARA ET O'BRIEN, 1994 (COLEOPTERA: CURCULIONIDAE) IN EUROPE

Юнаков, М. М., Храпов, Д. С. Виявлення епізойних водоростей на напівводних довгоносиках *Bagous tubulus* Caldara et O'Brien, 1994 (Coleoptera: Curculionidae) в Європі. *Вісті Харківського ентомологічного товариства*. 2020. Т. XXVIII, вип. 2. С. 29–31. DOI: 10.36016/KhESG-2020-28-2-3.

Під час вивчення серії *Bagous tubulus* Caldara et O'Brien, 1994 з Львівської області України на жуках були виявлені епізойні водорості. Зелені водоростеві мати малого та середнього розміру локалізуються на передньоспинці, надкрилах і стегнах жуків. Припускається, що специфічний шар виділень і мікроструктура лусочок, якими вкрито тіло, у сукупності з напівводним способом життя сприяють росту водоростей. Залишається невідомим як водорості впливають на життя жуків і властивості покривів тіла. Таксономічний склад матів залишається невідомим, але, опираючись на відомості про епізойні організми, які зібрано дотепер у різних частинах світу, можна припустити, що це представники Ulvophyceae, Chlorophyceae та/або Cyanobacteria. 1 рис., 17 назв.

Ключові слова: водоростеві мати, епізойна флора, симбіоз, коменсалізм, жуки, Chlorophyta.

Юнаков, Н. Н., Храпов, Д. С. Обнаружение эпизойных водорослей на полуводных долгоносиках *Bagous tubulus* Caldara et O'Brien, 1994 (Coleoptera: Curculionidae) в Европе. *Известия Харьковского энтомологического общества*. 2020. Т. XXVIII, вып. 2. С. 29–31. DOI: 10.36016/KhESG-2020-28-2-3.

В ходе изучения серии *Bagous tubulus* Caldara et O'Brien, 1994 из Львовской области Украины на жуках были обнаружены эпизойные водоросли. Зелёные водорослевые маты мелкого и среднего размера локализуются на переднеспинке, надкрыльях и бёдрах жуков. Предполагается, что специфический слой выделений и микроструктура чешуек, покрывающих тело, в совокупности с полуводным образом жизни способствуют росту водорослей. Остаётся неизвестным как водоросли влияют на жизнь жуков и свойства покровов тела. Таксономический состав матов остаётся неизвестным, но, опираясь на сведения об эпизойных организмах, собранных до сих пор в разных частях мира, предполагается, что это могут быть представители Ulvophyceae, Chlorophyceae и/или Cyanobacteria. 1 рис., 17 назв.

Ключевые слова: водорослевые маты, эпизойная флора, симбиоз, комменсализм, жуки, Chlorophyta

Yunakov, N., Khrapov, D. Discovery of epizoic algae on semiaquatic weevils *Bagous tubulus* Caldara et O'Brien, 1994 (Coleoptera: Curculionidae) in Europe. *The Kharkov Entomological Society Gazette*. 2020. Vol. XXVIII, iss. 2. P. 29–31. DOI: 10.36016/KhESG-2020-28-2-3.

During examination of *Bagous tubulus* Caldara et O'Brien, 1994 series collected in Lviv Region of Ukraine the epizoic algae were detected. Small- and medium-sized green spots are constrained to the dorsal and lateral surfaces of pronotum, elytra, and femora of beetles. We assume that succidations, microstructure of scales along with semiaquatic way of life provides optimal substrate for growth of algal mats. It is still unclear how algal mats affect beetle life or properties of scales and coating. Taxonomic composition of those mats is unknown yet. According to available data on epizoic organisms, we presume that it may be the species of Ulvophyceae, Chlorophyceae, and/or Cyanobacteria. 1 fig., 17 refs.

Key words: algal mats, epizoic flora, symbiosis, commensalism, beetles, Chlorophyta.

Introduction. Taxonomic diversity, hosts and topology of photosynthetic epizoic symbionts. Epizoic communities of green algae and cyanobacteria on vertebrates and terrestrial arthropods are forming mats. All known terrestrial epizoic algae are restricted to Ulvophyceae and Chlorophyceae, the phylogenetically related classes of Chlorophyta (Leliaert *et al.*, 2016).

Mats formed by monospecific or compound multispecific communities of algae. Sometimes algae co-occur with various species of Cyanobacteria. In some cases, algal and cyanobacterial mats provide a substrate for further growth of liverworts (Machado, Vital, 2001) and some other bryophytes (Gradstein, Vitt, Anderson, 1984), later multilevel communities constrained to mountain rainforests of Papua New Guinea, Madagascar, and Tropical America.

Vertebrates. Mammals. Molecular study of hair symbionts taken from six sloth species in Costa Rica and Panama revealed the diversity of algae comprising three co-occurrence patterns: non-specific terrestrial genera and stenotopic algal genera which includes the remarkable *Trichophilus* restricted to cloth hairs (Suutari *et al.*, 2010).

Reptiles. Algae and liverworts are documented on lizards in the rainforests of Mexico (Gradstein, Equihua, 1995). Various taxa of algae and cyanobacteria are growing on freshwater turtles in Europe (Fayolle *et al.*, 2016).

Yunakov N. N. Natural History Museum University of Oslo, Norway, e-mail: n.yunakov@gmail.com, ORCID: 0000-0002-0824-7804
Khrapov D. D. Ukrainian Entomological Society, Lviv, Ukraine, e-mail: denys.khrapov@gmail.com, ORCID: 0000-0002-9868-1435

Received 25.11.2020 **Accepted 15.12.2020 by Dr. Yu. A. Guglya** **Published 21.12.2020**

Arthropods. Opiliones. A remarkable case of co-occurrence epizoic cyanobacteria and liverworts on harvestmen has been documented in Brazil (Machado, Vital, 2001). Harvestmen with living cyanobacteria are known from Trinidad (Young, Moore, Townsend, 2018).

Diplopoda. Martínez-Torres, Flórez Daza, and Linares-Castillo (2011) described co-occurrence of platyrhacid millipedes with ten epizoic bryophyte species in Colombia.

Coleoptera. A number of cases of growing algae on beetles are noted frequently by entomologists throughout the tropical regions, *e.g.*, *Geobyrsa nodifera* Pascoe, 1872 from Panama (Jolivet, 1998). Species of Tenebrionidae, Anthribidae, Brentidae, and Curculionidae (*e.g.*, *Holonychus* Schoenherr, 1840 and *Lithinus* Klug, 1833) bearing algae were observed by macro-photographer Paul Bertner in Madagascar (https://rainforests.smugmug.com). Comprehensive study of epizoic organisms associated with weevils of the genus *Gymnopholus* has been done in Papua New Guinea (Gressitt, Sedlacek, 1967, 1970; Gressitt, 1966a, 1966b, 1977; Gressitt, Samuelson, Vitt, 1968) and recently confirmed by Riedel and Kilmaskossu (2017). Communities are forming a compound pattern of co-occurrence of bryophytes, lichens, and mites. Gressitt assumes such coexistence provides benefits to weevils, *e.g.*, camouflage properties, hence, beetles might stimulate the growth of those organisms via body succidations and specific pitted microsculpture of the body surface.

No evidence of epizoic plants on weevils is reported yet from Europe.

Materials and methods. Beetles were collected by sweeping flooded grasses in shallow mineral springs (depth ca. 30–40 cm). Water from these springs is enriched with flammable natural gas. Four specimens are preserved for further algological and molecular study. Sampling and observations have been done by Denys Khrapov.

Depositories: DMLU — State Museum of Natural History, Lviv; KUMN — Museum of Nature of the Vasyl Karazin Kharkiv National University; KhDC — private collection of Denys Khrapov, Lviv.

Results and discussions.

Genus *Bagous* Germar, 1817

Bagous tubulus Caldara et O'Brien, 1994

Material. Ukraine: Lviv Reg., Stryi Distr., near Rozgirche, 49.120456, 23.694633, shallow spring, 13.07.2020, aquatic net — 2 spec. (KhDC); *idem*, 14.07.2020 — 5 spec. (KhDC); *idem*, 26.07.2020 — 17 spec. (5 — KhDC, 4 — DMLU, 8 — KUMN).

During examination of *Bagous tubulus* series collected in Lviv Region of Ukraine the epizoic green algae were detected. 23 of 24 specimens bear algal mats**.** Small- and medium-sized green spots are constrained to the dorsal and lateral surfaces of pronotum, elytra, and femora of beetles (Fig. 1). *Bagous* species have granulate, moderately to strongly pitted non-hydrofuge scales with clear and shellac-like or dense and subopaque waterproof coating, later often concealing scales and cuticle (O'Brien, Askevold, 1992).

We assume that such coating along with a semiaquatic way of life provides an optimal substrate for the growth of algal mats. It is still unclear how algal mats affect beetle life or properties of scales and coating. Taxonomic composition of those mats is a subject of further study. We presume that it may be the species of Ulvophyceae, Chlorophyceae, and/or Cyanobacteria.

REFERENCES

Fayolle, S., Moriconi, C., Oursel, B., Koenig, C., Suet, M., Ficheux, S., Logez, M., Olivier A. 2016. Epizoic algae distribution on the carapace and plastron of the European pond turtle (*Emys orbicularis* Linnaeus, 1758): A study from the Camargue, France. *Cryptogamie, Algologie*, **37**(4), 221–232. DOI: https://doi.org/10.7872/crya/v37.iss4.2016.221.

Gradstein, S. R., Equihua, C. 1995. An epizoic bryophyte and algae growing on the lizard *Corythophanes cristatus* in Mexican rain forest. *Biotropica*, **27**(2), 265–268. DOI: https://doi.org/10.2307/2389005.

Gradstein, S. R., Vitt, D. H., Anderson, R. S. 1984. The epizoic occurrence of *Daltonia angustifolia* (Musci) in Papua New Guinea. *Cryptogamie, Bryologie-Lichénologie*, **5**(1–2), 47–50. URL: https://www.biodiversitylibrary.org/item/290486#page/51.

Gressitt, J. L. 1966a. Epizoic symbiosis: The Papuan weevil genus *Gymnopholus* (Leptopiinae) symbiotic with cryptogamic plants, oribatid mites, rotifers and nematodes. *Pacific Insects*, **8**(1), 221–280. URL: http://hbs.bishopmuseum.org/pi/pdf/8-1p221.pdf.

Gressitt, J. L. 1966b. The weevil genus *Pantorhytes* (Coleoptera), involving cacao pests and epizoic symbiosis with cryptogamic plants and microfauna. *Pacific Insects*, **8**(4), 915–965. URL: http://hbs.bishopmuseum.org/pi/pdf/8(4)-915.pdf.

Gressitt, J. L. 1977. Papuan weevil genus *Gymnopholus*: Third supplement and further studies in epizoic symbiosis. *Pacific Insects*, **17**(2–3), 179–195. URL: http://hbs.bishopmuseum.org/pi/pdf/17(2)-179.pdf.

Gressitt, J. L., Samuelson, G. A., Vitt, D. H. 1968. Moss growing on living Papuan moss-forest weevils. *Nature*, **217**(5130), 765–767. DOI: https://doi.org/10.1038/217765a0.

Gressitt, J. L., Sedlacek, J. 1967. Papuan weevil genus *Gymnopholus*: Supplement and further studies in epizoic symbiosis. *Pacific Insects*, **9**(3), 481–500. URL: http://hbs.bishopmuseum.org/pi/pdf/9(3)-481.pdf.

Gressitt, J. L., Sedlacek, J. 1970. Papuan weevil genus *Gymnopholus*: second supplement with studies in epizoic symbiosis. *Pacific Insects*, **12**(4), 753–762. URL: http://hbs.bishopmuseum.org/pi/pdf/12(4)-753.pdf.

Jolivet, P. 1998. *Interrelationship Between Insects and Plants*. CRC Press, Boca Raton, FL, USA, 1–336. DOI: https://doi.org/10.1201/9781498719360.

Fig. 1. *Bagous tubulus* with epizoic algae.

Leliaert, F., Tronholm, A., Lemieux, C., Turmel, M., DePriest, M. S., Bhattacharya, D. K., Kenneth, G., Fredericq, S., Zechman, F. W., Lopez-Bautista, J. M. 2016. Chloroplast phylogenomic analyses reveal the deepest-branching lineage of the Chlorophyta, Palmophyllophyceae class. nov. *Scientific Reports*, **6**(1), 25367. DOI: https://doi.org/10.1038/srep25367.

Machado, G., Vital, D. M. 2001. Occurrence of epizoic cyanobacteria and liverworts on a Neotropical harvestman (Arachnida: Opiliones). *Biotropica*, **33**(3), 535–538. DOI: https://doi.org/10.1111/j.1744-7429.2001.tb00208.x.

Martínez-Torres, S. D., Flórez Daza, Á. E., Linares-Castillo, E. L. 2011. Meeting between kingdoms: Discovery of a close association between Diplopoda and Bryophyta in a transitional Andean-Pacific forest in Colombia.. *International Journal of Myriapodology*, **6**: Proceedings of the 15th International Congress of Myriapodology (Brisbane, Australia, 18–22 July 2011), 29–36. DOI: https://doi.org/10.3897/ijm.6.2187.

O'Brien, C. W., Askevold I. S. 1992. Systematics and evolution of weevils of the genus *Bagous* Germar (Coleoptera: Curculionidae), I. Species of Australia. *Transactions of the American Entomological Society*, **118**(4), 331–452. URL: www.jstor.org/stable/25078563.

Riedel, A., Kilmaskossu, A. 2017. Revision of the subgenus *Niphetoscapha* Heller of *Gymnopholus* Heller (Coleoptera, Curculionoidea, Entiminae, Eupholini) and a new species with epizoic symbiosis from West New Guinea. *Zootaxa*, **4254**(3), 339–356. DOI: https://doi.org/10.11646/zootaxa.4254.3.3.

Suutari, M., Majaneva, M., Fewer, D. P., Voirin, B., Aiello, A., Friedl, T., Chiarello, A. G., Blomster, J. 2010. Molecular evidence for a diverse green algal community growing in the hair of sloths and a specific association with *Trichophilus welckeri* (Chlorophyta, Ulvophyceae). *BMC Evolutionary Biology*, **10**, 86. DOI: https://doi.org/10.1186/1471-2148-10-86.

Young, V. A., Moore, M. K., Townsend, V. R., Jr. 2018. Epizoic cyanobacteria associated with harvestmen (Arachnida: Opiliones) from Tobago, West Indies. *Living World: Journal of the Trinidad and Tobago Field Naturalists' Club*, **2018**, 94–98.

Department of Zoology, Natural History Museum, University of Oslo, Norway,
Ukrainian Entomological Society