Rocetelion humerale (Zetterstedt, 1850) (Diptera, Keroplatidae) rediscovered in Norway after more than 100 years, with description of the larva and its habitat

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The large and conspicuous keroplatid species *Rocetelion humerale* (Zetterstedt, 1850) was previously documented with a single record from Norway only, a more than one hundred-year-old record of a male from Erfjord in Rogaland County, published in 1914, for which the voucher specimen has been searched for in vain in museum collections. In the summer of 2020, a new record of an adult male was photo-documented alive and then sampled from a barn in the village Førde in Sveio municipality, Vestland County. The following year, in October 2021, a population of larvae were located at a large, decaying log of beech (*Fagus sylvatica*) in the same area, a parsonage garden consisting of seminatural park landscape dominated by beech located just some 250 meters from the barn where the male was collected. The population of larvae living on this log was investigated also in 2022 with observations of active larvae in wintertime (early January), no findings in August but numerous spins and several larvae observed again in October. The living larvae were photo-documented and filmed. Five larvae were sampled, four of them successfully associated with the male through DNA barcoding. Both the adult male and the larvae are described and richly illustrated. *Rocetelion humerale* is redlisted as endangered (EN) in Norway and the new records are discussed in a wider context of records and the previous scarce knowledge of its biology abroad. The new data on its biology underscores the importance of leaving huge, windfallen logs of broadleaved trees to decay without cleaning up by removing them, and a practice to create fauna depots with large logs of dead wood in semi-park and park landscapes is suggested to help the species' survival in lack of natural habitats with similar qualities.

Key words: Diptera, Keroplatidae, *Rocetelion*, Norway, new records, new distribution, larval biology, DNA barcoding.

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Introduction

The family Keroplatidae (named *spinnmygg* in Norwegian) hereafter named keroplatids belongs to the superfamily Sciaroidea in the infraorder Bibionomorpha (Ševčík *et al.* 2016). Recently, Mantič *et al.* (2020) reclassified the family based on molecular data, to include the small, mainly tropical family Lygistorrhinidae as subfamily Lygistorrhininae, raised the subfamily Platyurinae for a few putatively primitive genera and questioned the traditionally used tribes Keroplatini and Orfelini of subfamily Keroplatinae. With nearly 1000 described species in almost 100 genera, it is one of the more diverse families in the infraorder although far less species diverse than the gall midges (Cecidomyiidae), the true fungus gnats (Mycetophilidae) and the black fungus gnats (Sciaridae). Moreover, keroplatids, unlike the other families of Sciaroidea, are more diverse in tropical and subtropical environments than at higher latitudes towards the north. The Nordic region is estimated to have 75 species (Kjærandsen 2022), many of them southern in distribution, of which only 38 so far have been published from Norway (Rindal *et al.* 2008).

The genus *Rocetelion* Matile, 1988 is a small genus consisting only of three Holarctic species, two Nearctic species and *Rocetelion humerale* (Zetterstedt, 1850) which is widespread in the Palaearctic region. The genus was revised by Fitzgerald (2019) who also summarized the sparce knowledge of larval stages for the genus.

The only previous Norwegian record of *Rocetelion humerale* stems from Erfjord in Rogaland County, based on the collections of Embrik Strand (1876–1947, see Breihagen 1994) and published by Lundström (1914). The record is not dated in the publication, but it is most likely from 1901 when Strand carried out a collecting expedition to Suldal and nearby areas. His collecting trip is detailed in a publication in *Årbok for Bergen Musem 1902* (Strand 1902). There he made no mention of the locality Erfjord but lists several localities around Suldal where he collected in September of 1901. Notably, the publication of Lundström (1914) is from the same year as Erfjord municipality was erected and this may be the reason for the locality name to be used for unprecise collection data originating from the area southwest of Suldal. The deposition of the materials studied was neither given by Lundström (1914), and the voucher specimen representing the published male has been search for in vain at the Natural History Museum in Oslo, at the Finnish Museum of Natural History (from where Lundström worked and published the record) and at Museum für Naturkunde in Berlin (Strand spent the first part of his career, between 1903 and 1922, in Germany, mainly in Berlin where he was associated with the museum).

Rocetelion humerale is redlisted as endangered (EN) in Norway (Gammelmo *et al.* 2021). Here new records are presented of an adult male and a viable population of larvae located in Førde in Sveio municipality, Vestland County, and the opportunity is taken to illustrate and briefly redescribe the adult male, and for the first time describe and illustrate in detail the larva and its habitat.

Materials and methods

Photos of living specimens, both a male and larvae, were taken handheld by Nikon D850 or D7500 cameras with a Nikon 60mm Micro Nikkor 2.8 lens fitted with a concave white plastic shield to diffuse and spread the light from the internal flash of the camera. Short videos were taken with the same cameras on a tripod by use of a Laowa 24mm Macro Probe lens with internal ring light.

An adult male collected with aspirator and four hand-picked larvae were dried from ethanol by baths in Hexamethyldisilazane (chemical formula: ([(CH3)3Si]2NH), acronym: HMDS, see Brown 1993) and then pinned. Another hand-picked larva is stored in glycerine. The male terminalia and the larval head capsule of a representative specimen were detached, cleared in hot lactic acid by short pulse-heating in a microwave oven, before being transferred to glycerol in excavated slides for microscope imaging. The dissection of the terminalia and head capsule for imaging of details of its parts is partly a destructive procedure resulting in fragmented specimens, but all parts were preserved and stored in glycerol in sealed microtubes on the pin together with the rest of the specimen. A Leica K5C microscope camera mounted on a Leica M205C stereomicroscope was used to capture images of detached and cleared terminalia and the larval head capsule. Stacked images were processed by use of Helicon Focus software and edited into a collage image by use of Adobe Photoshop. Enhanced focus was obtained by Topaz Sharpen AI (Artificial Intelligence) software.

One leg of the male and tissue of four larvae from fresh specimens were sent to the Canadian Centre for DNA barcoding, BIO (Guelph, Ontario, Canada), for DNA extraction and bi-directional Sanger sequencing as a part of the Norwegian Barcode of Life (NorBOL) initiative (see Kjærandsen 2022), itself a branch of the

International Barcode of Life project (iBOL).

Terminology of the adult follows Blagoderov & Ševčík (2017) while that of the larva follows Madwar (1937).

The studied material is deposited in museum collections with the following abbreviations: TMU = Norway, Tromsø, UiT–The Arctic University of Norway, Tromsø University Museum (The Arctic University Museum of Norway). MZLU = Sweden, Lund, Department of Biology, Biological Museum, Entomological collections.

Results

The adult male

An adult male of *Rocetelion humerale* was discovered in the window frame of a barn in the morning of 26 July 2020, after the large barn doors had stayed open and a light was left on during the previous night (Figure 1A). The barn belongs to the "tenant farm" (*husmannsplass* in Norwegian) Solheimshaugen, where the author grew up, and is associated with the larger parsonage farm Solheim in Førde, Sveio municipality in Vestland County. This collection method is extensively used by the author to attract fungus gnats to a window for photographing before sampling. When the morning light gets stronger than the indoor light (Figure 1B) many insects attracted to the light during the night move over to the window to try to get out but are left trapped there. After some time spent trying to get through the window they mostly sit and rest in the window frame where they are easily approached with a camera without the quick escape reaction normally seen in nature. In this way the photographed specimens can further be sampled with an aspirator and identified under the microscope, and even DNA barcoded, after photos of them alive are taken.

Rocetelion humerale is a large, conspicuous keroplatid species. With a body length of about 12 mm (males, females may be larger) and laterally flattened antenna it reminds of species of the genus *Keroplatus* Bosc, 1792, which range among the very largest keroplatids, but it is slimmer, with a darker, reddish striped body colour, and its slender abdomen is reaching far beyond the tip of the wings in resting position (Figure 1A). Its wing (Figure 2) has a faint shade apically and a darker patch preapically over the radial veins. Its male terminalia (Figure 3) have a simple, primitive outline, with characteristically rounded, club-shaped gonostyli (Figure 3E–F) quite different from the terminalia found in species of *Keroplatus*. In our region *Rocetelion humerale* also resembles the slightly smaller species *Cerotelion striatum* (Gmelin, 1790) which can be separated based on shorter abdomen, wings with a distinct central spot in the radial sector in addition to the apical shading, and by having strongly dentated gonostyli (for comparison see figure 2 of Mantič *et al.* 2020).

Material: 1 male, **HOY**, Vestland (previous Hordaland), Sveio, Førde, Solheimshaugen, 59.6150056 N 5.4754978 E, 26 July 2020, leg/det. J. Kjærandsen, Tromsø University Museum, TMU, TSZD-JKJ-111213. The specimen was collected with an aspirator and successfully DNA-barcoded with deposited sequence on BOLD (BoldSystems.org) assigned to BIN BOLD:ACG4926. It is now pinned with its cleared terminalia stored in glycerol in a micro-vial on the same pin as the rest of the specimen.

Other material of *Rocetelion humerale* studied by the author: **SWEDEN**: JÄ, Berge, Alsen, 63°23'09"N, 013°55'52"E, 8 August 1840 (leg. /det. J. W. Zetterstedt) — **HOLOTYTPE male** (lacking abdomen), MZLU, SPM-012111; LU, Gällivare, Ruotjajaure, 11 August 1923 (leg. K.-H. Forslund) — MZLU, SPM-034582 (female); ÖG, Sturefors Nature Reserve, 58°19'43"N, 015°46'08"E, 15, 17 August 1990 (Leg. M. Wadstein) — MZLU, SPM-034578 (male); SK, Linhultet, 5 km E Åsljunga, 56°18'33"N, 013°26'47"E, 2-28 August 1993 (Leg. M. Sörensson) — MZLU, SPM-034580 (male); SM, Växsjö, Bokelid, 56°59'32"N, 014°59'11"E, 14 July 1967 (Leg. S. Gaunitz) — MZLU, SPM-011865 (male); SM, Jönköking, Strömsberg, 57°45'15"N, 014°11'00"E, Bäck, 9 August 2020 (Leg. M. Andersson) — TMU, TSZD-JKJ-111483 (male); SÖ, Nytorpsravinen vid Misteln, lövskogsravin, 6 July 1989 (Leg. H. Andersson) — MZLU, SPM-034579 (male); SÖ, Nävekvarn, Nävsjön Domänreservat, 58°39'16"N,

FIGURE 1. A. Male *Rocetelion humerale* (Zetterstedt, 1850) photographed alive before sampling in the window frame of a barn at Førde in Sveio, Vestland County, 26 July 2020 (TMU, TSZD-JKJ-111213). **B**. The barn window.

FIGURE 2. Wing of *Rocetelion humerale* (Zetterstedt, 1850) (specimen from Sweden).

016°44'31"E, 12 May–14 July 1990 (Leg. B. Viklund, L. O. Wikars & H. Ahnlund) — MZLU, SPM-034581 (male); TO, Kiruna, Abisko, Ridonjiras utlopp, 68.365037 N, 18.787793 E, 22 July 1983 (Leg. H. Andersson) — MZLU, SPM-011864 (male). **FINLAND**: Korospohja, 61°55'27"N, 025°44'53"E, undated (leg. L. Huggert) — MZLU, SPM-036529 (male).

The larvae

A year after the male was recorded field work was carried out in the same area in mid-October 2021, when the weather was mild and without frost. When searching for various larvae of Sciaroidea for DNA barcoding, numerous unusually large net-spinning larvae were found under and inside a huge log of beech (*Fagus sylvatica*) in the parsonage garden Solheim (Figure 4A–B), just some 250 meters from the barn in Solheimshaugen where the male was collected. The larvae were filmed (videolink at: https://en.uit.no/forskning/forskningsgrupper/sub?p_document_id=488838&sub_id=794575) and photographed alive before four of them were sampled for DNA barcoding.

Since the larvae of *Keroplatus* are cigar-shaped, somewhat dorsoventrally flattened and known to be mainly associated with sporophores of bracket fungi (see Fang *et al.* 2018), suspicion was immediately directed towards *Rocetelion humerale* when the larvae first were discovered on the beech log, although *Cerotelion striatum* could not be excluded. The author's experience with the latter (see figure 2 in Mantič *et al.* 2020) suggested some differences both in habitus of the larvae and their habitat. The suspicion was firmly confirmed after DNA barcoding resulted in all specimens from Norway ended in a distinctly separated Barcode Index Number (BIN) on BOLD, currently consisting of six adults and four larvae. The BIN BOLD:ACG4926 is separated by 12.36% from its nearest neighbour on BOLD, an unidentified keroplatid species from Costa Rica in BOLD:ADY0573.

In early January 2022, the author was back at the site and discovered then one larva of the same kind seemingly being active even at freezing conditions with temperatures just below zero for a brief time. During a visit in early August 2022, however, the log was searched for larvae without finding any. Then in mid-October 2022 the site was again revisited, and several larvae were observed in activity. This time the first frosty night had occurred two days earlier but at least five different larvae were observed on the surfaces when the weather was mild again. Even though fewer larvae were seen on the surface compared to in October 2021, distinct spins (Figure 4C–D) at eight different sites along the log indicated a viable population where most of the larvae were hiding inside the crevices and holes of the decaying log due to the colder weather. This time the log was left untouched and only one larva was sampled not to disturb the viable but probably fragile population too much. Several similarly decaying but smaller logs of beech in the area, both in Solheim, Solheimshaugen and wider in the surrounding village were searched for larvae or spin without finding any. This included a quite

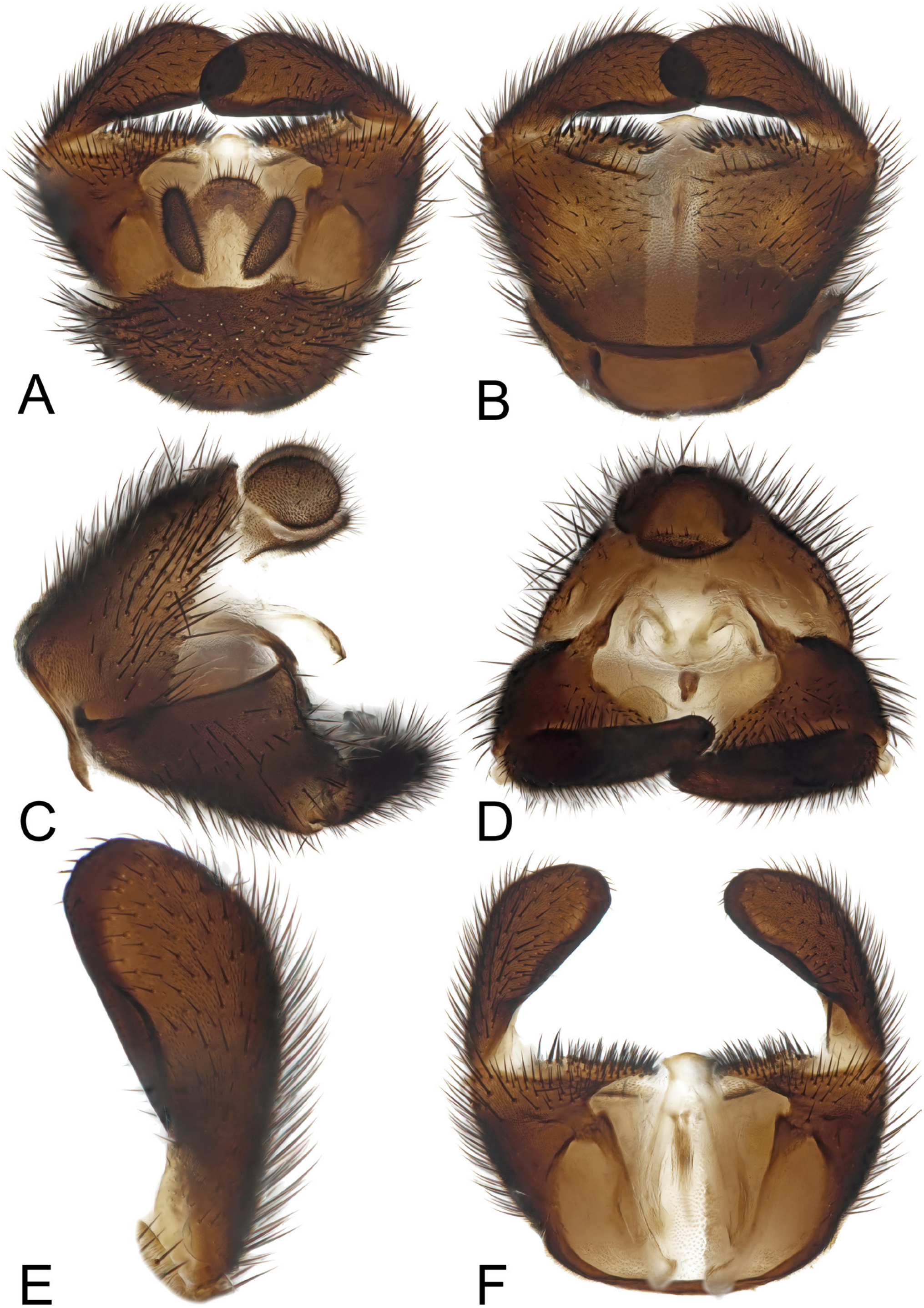

FIGURE 3. Male terminalia of *Rocetelion humerale* (Zetterstedt, 1850) (TMU, TSZD-JKJ-111213). **A**. Dorsal view. **B**. Ventral view. **C**. Lateral view. **D**. Caudal view. **E**. Gonostylus enlarged, dorsal view. **F**. Dorsal view with tergal parts removed displaying the internal aedeagal apparatus and gonocoxal apodemes.

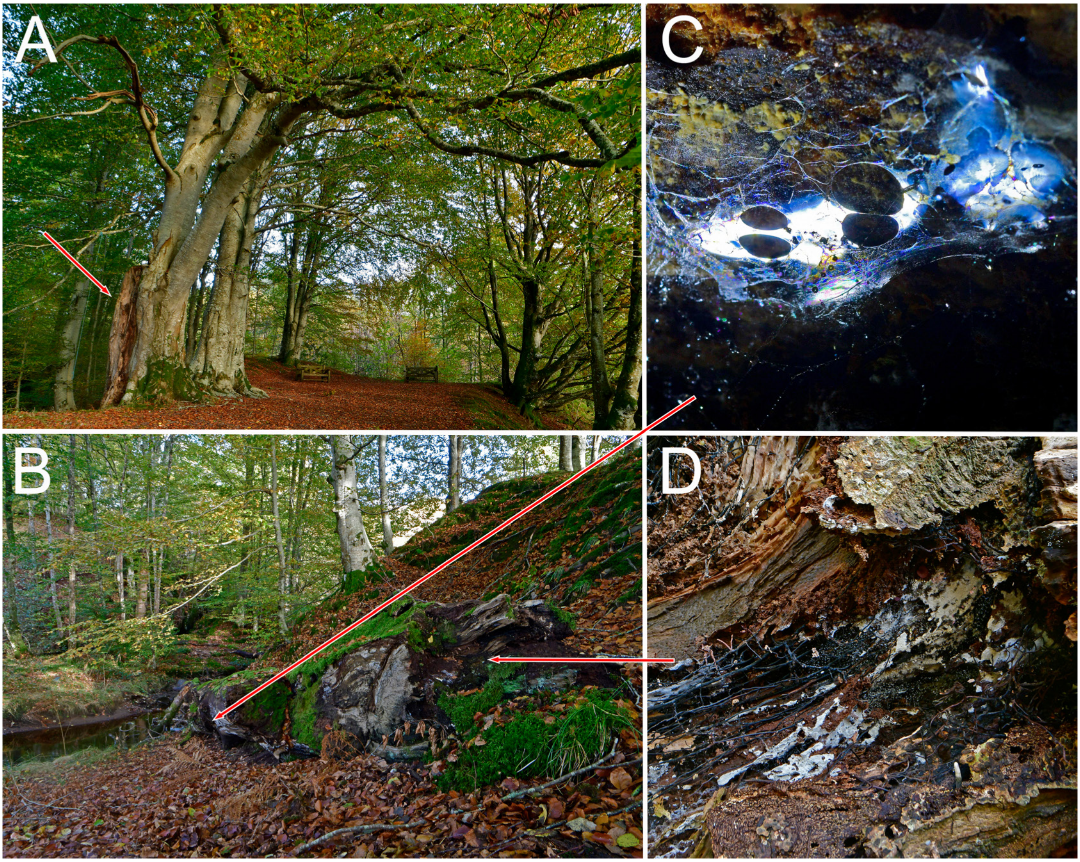

FIGURE 4. The beech park landscape in the parsonage at Førde in Sveio, Vestland County and the decaying log where larvae of *Rocetelion humerale* (Zetterstedt, 1850) were located. **A**. The mother-tree of beech from where a large branch broke off some 40 years ago (marked with red arrow). The two largest trees were planted there likely some 150 years ago when the parsonage was established in 1872. The stem of the mother-tree measures 4.5 meters in circumference one meter above ground level. **B**. The huge branch-log of some 2.5 meters in circumference that has been lying and decaying there since it broke off some 40 years ago. This log is where larvae of *Rocetelion humerale* were located. **C**. Part of a larval spin that formed a thin film reflected by the flashlight. **D**. Part of the decaying end of the log where several spins were located by the droplets in the spin, as seen in the centre of the image.

large beech log in Solheimshaugen, just outside the barn where the adult was found, that was cut into short pieces by use of a chain saw many years ago and subsequently left lying and decaying.

The larvae of *Rocetelion humerale* (Figure 5) is unusually large, slender, and cylindrical except anteriorly and posteriorly where the body is somewhat dorsoventrally flattened. Due to its very flexible body, it is difficult to measure its length precisely, but stretched out some mature larvae may reach a length close to 3 cm. The longest larva preserved in ethanol (where they shrink a bit) measured about 2.4 cm. The living larva is semi-transparent, with a reddish-brown body surface tightly striped transversely, this giving the impression of false segments reminiscent of a small annelid rather than a dipteran larva. The head has prominent anterior corners giving it a square appearance, that together with the false segmentation is typical for larger keroplatids. The three-segmented thorax is irregularly patterned with dark spots laterally on a pale, off-white background. The nine-segmented abdomen is tightly set with dark transverse lines and narrow oval rings. The posterior tip (telson) is flattened and truncated, with a pair of large lateral, dark

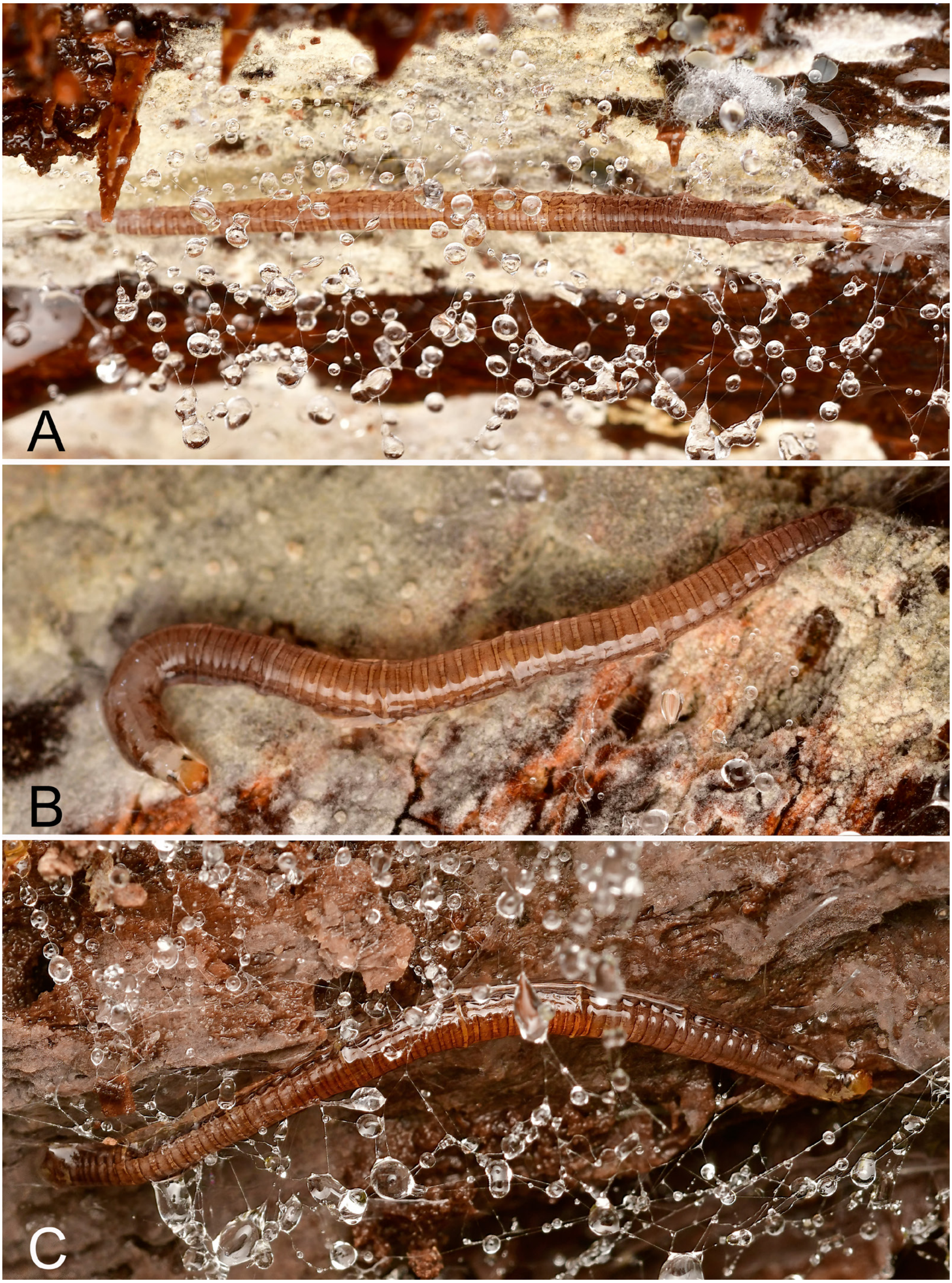

FIGURE 5. Larvae of *Rocetelion humerale* (Zetterstedt, 1850) photographed alive before sampling from the log of beech in the parsonage at Førde in Sveio, Vestland County. **A**. Specimen TSZD-JKJ-112328 (sampled 24 October 2021) gliding in a central slime-tube of the spin placed in a crevice infected with a whitish resupinate crust fungus, larva seen in ventral view. **B**. Specimen TSZD-JKJ-112329 (sampled 24 October 2021) on the log, larva seen in dorsal view. **C**. Specimen TSZD-JKJ-112926 (sampled 21 October 2022) in a typical spin with droplets, without visible fungal tissue in the vicinity, larva seen in lateral view.

spots. The head capsule (Figure 6) is yellowish brown and pentagonal in dorsal view. The frontal, clypeal plate (Figure 6A) is diamond-shaped in dorsal view, with a smooth incision for the antenna laterally. The lateral, epicranial plate has a concave ventral margin (Figure 6B) and a strongly chitinized posterodorsal incision (Figure 6C), likely serving as a firm attachment point for muscles of prothorax. The antenna (Figure 6A,C) is large, smoothly convex as an eye-looking lens, firmly framed by a chitinous ring (Figure 6D) and situated at the anterior corner of the head capsule. The eye (Figure 6C) is tiny, vestigial, and composed of a transparent membrane overlying a layer of pigmented cells, situated laterally below the antenna. The labrum and associated clypeus (Figure 6A,C) are forming a narrow, smooth, snout-shaped structure anteriorly, supported with a chitinous frame armed with two teeth ventrolaterally. The mandible (Figure 6B–C,E) is subrectangular in shape. It carries 6 teeth along its inner border, of which the apical three are more developed than the medial ones. A single strong tooth is also present on the superior lamella. The maxilla (Figure 6B–C,F) carries 16 small teeth along its inner border. Posteriorly it ends in a chitinized rod which lies dorsal to the maxillary plate. The maxillary plate (Figure 6B) is well developed and consists of a rectangular plate of chitin with two sensory hairs placed medially and posterolaterally. The two maxillary plates meet at the mid-ventral line. The hypopharynx (Figure 6G–H) has a chitinous frame with double cross sections, A-shaped in ventral view, L-shaped in lateral view, followed posteriorly by a chitinous anterior margin of the fore gut.

The larva greatly resembles that of *Cerotelion striatum*, described in detail by Madwar (1937), but differs in several details of the head capsule. The living larva of *Cerotelion striatum*, however, is smaller and appears to be differently striped with broader dark transversal stripes and was by the author found on a small decaying twig of goat willow, *Salix caprea* in southern Sweden (Mantič *et al.* 2020).

The larvae construct a loose net of silk strands with large drops of a blank waterish fluid (Figures 4C–D, 5A,C, videolink at: https://en.uit.no/forskning/forskningsgrupper/sub?p_document_id=488838&sub_id=794575). The nets can reach a considerable size of a decimetre or more on overhanging surfaces of the log, either tightly associated with resupinate crust fungi (Figure 5A) or in some cases seemingly not directly associated with any fungi (Figure 5C). Several larvae, different in size, were sometimes seen in the same continuous net. The central part of the net usually formed a strong, central slime-tube in or on which the larvae slide back and forth (Figure 5A). Other areas of the net sometimes formed a thin film of slime as seen reflected by the flashlight in Figure 2C. Such areas may serve to catch spores that the larvae live on from nearby resupinate crust fungi. The most frequently observed activity of the larvae was to create new silk strands in various directions out from the central sliding part of the net and digest other such strands and their droplets. This is likely how the larvae feed on fungal spores. No indications of predatorial behaviour were observed, nor were any insects seen trapped in the net.

Material: Four sampled larvae, HOY, Vestland (previous Hordaland), Sveio, Førde, Solheim, 59.6130674 N 5.4780975 E, 24 October 2021, leg/det. J. Kjærandsen, Tromsø University Museum, TMU, TSZD-JKJ-112328, TSZD-JKJ-112329, TSZD-JKJ-112337, TSZD-JKJ-112349. One sampled larva at the same locality, 20 October 2022, TMU, TSZD-JKJ-112926. Four larvae were successfully DNA-barcoded with deposited sequences on BOLD (BoldSystems.org) assigned to BIN BOLD:ACG4926. The larvae are either stored in glycerol or HMDS-dried and pinned as the adult male.

The habitat

The climate in coastal areas of western Norway is mild Atlantic, usually without longer periods of snow cover and frost during wintertime. The area making up the parsonage Solheim and the associated tenant farm Solheimshaugen consists mainly of south- and west-faced broad-leaved deciduous forest forming a semi natural park landscape in the parsonage garden but appearing more natural in some parts of the area, although heavily influenced by the housing in other parts.

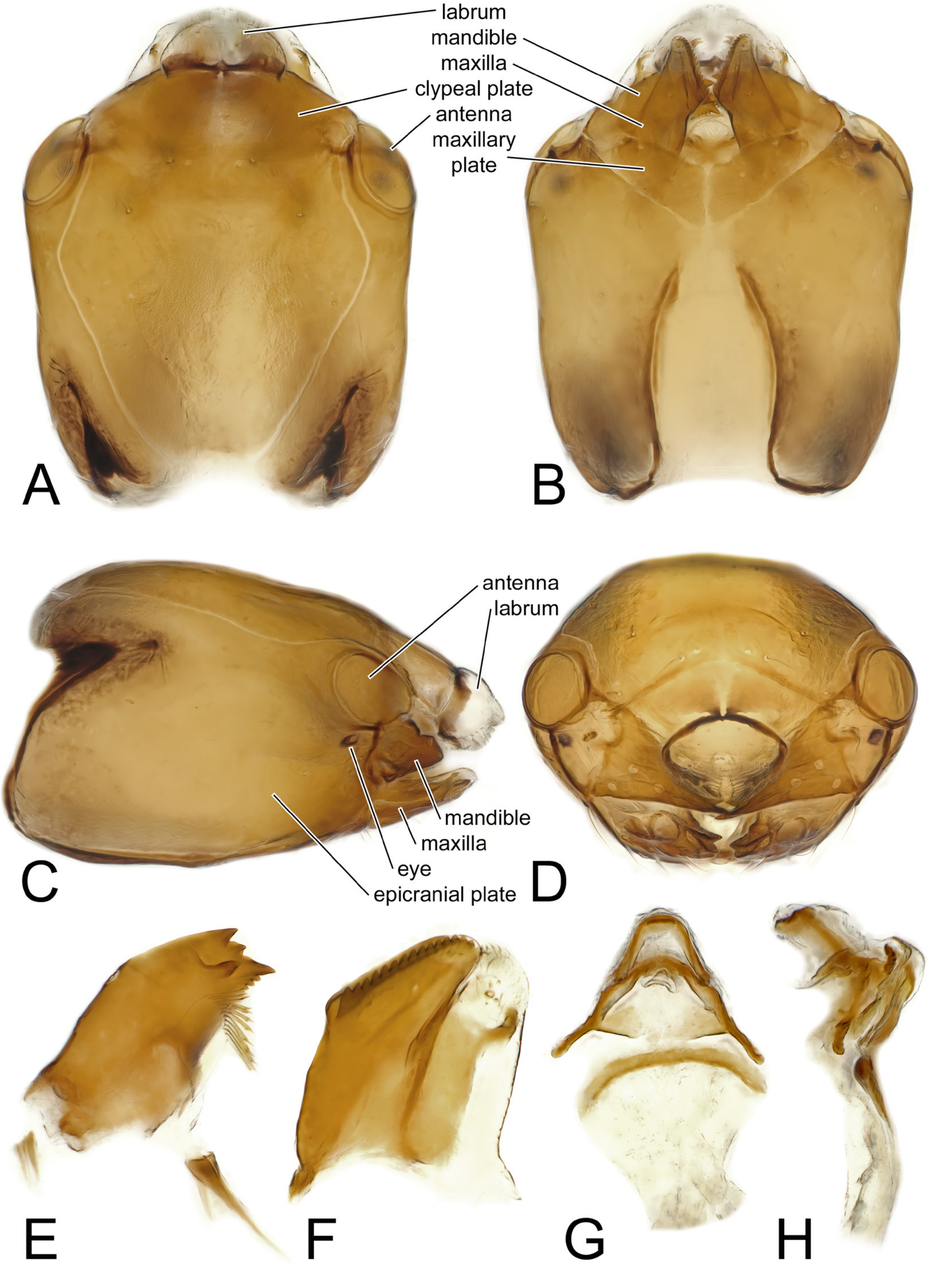

FIGURE 6. Head capsule of larva of *Rocetelion humerale* (Zetterstedt, 1850) (TMU, TSZD-JKJ-112328). **A**. Dorsal view. **B**. Ventral view. **C**. Lateral view. **D**. Caudal view. **E**. Mandible detached and enlarged, dorsal view. **F**. Maxilla detached and enlarged, dorsal view. **G**. Hypopharynx detached and enlarged, dorsal view. **H**. Hypopharynx detached and enlarged, lateral view.

Tree species that dominate in the area include ash (*Fraxinus excelsior*), beech (*Fagus sylvatica*), common alder (*Alnus glutinosa*), European oak (*Quercus robur),* grey alder (*Alnus incana*) and hazel (*Corylus avellana*). To the south and west one finds the central part of the village Førde. To the north and east there is an abrupt change into pine forest (*Pinus sylvestris*) while nearby parts of the landscape and village to the west and north have lately been transformed into a large, artificial Rhododendron (*Rex* spp.) park called "Rex garden" (https://www.fjordnorway.com/en/see-and-do/rex-garden-in-sveio). The first beech trees are thought to originally have been planted there some 150 years ago when the parsonage garden was established in 1872. Planted beech of considerable size also grow in Solheimshaugen and other places in the village, and beech trees are now found all over the place and must have spread naturally from these first, planted trees. The two large beech trees (Figure 4A) where larvae were located are no doubt the oldest and largest ones in the area. They measure 4.5 and 4 meters in circumference, respectively, one meter above ground level. Some 40 years ago a huge branch-log of some 2.5 meters in circumference broke off and has since been lying and decaying there gradually creating a favourable habitat for the larvae of *Rocetelion humerale* (Figure 4B). The log is currently in a late stage of decay, full of small cavities in the sapwood, overgrown with mosses, infected mostly with whitish resupinate crust fungi, unknown to the author, without any large sporophores of bracket fungi observed. The site is shaded by the large trees above and a stream pass by next to the decaying log which has its tip soaked into the stream.

Discussion

Rocetelion humerale is widespread in the Palaearctic region but appears to be rather scarcely recorded everywhere with only 27 records on Global Biodiversity Information Facility (GBIF Secretariat), all restricted to the Nordic and Baltic Regions. Fauna Europaea (Chandler 2013) lists presence of the species in many countries in Northern and Central Europe south to Hungary as well as the European parts of Russia and the East Palaearctic Region. Although the author has invested considerable efforts into recording Sciaroidea flies in all of Norway (see Kjærandsen & Søli 2020 for the family Mycetophilidae) *Rocetelion humerale* has not been recorded anywhere else in the country. Such a large and conspicuous species is not likely to have gone undetected in Norwegian museum collections if it were frequently present in insect trap samples. In Sweden, from where the species was described (Zetterstedt 1850) and where the author also have first-hand experience with keroplatids (Kjærandsen *et al.* 2007), rather few scattered records, mostly old ones, exist all the way from the south to the north. An unusually northern record stems from subalpine birch forest in Abisko, at the delta of Ridonjira River which is at latitude 68.37 north and about 340 m a.s.l.

It appears that species of *Rocetelion* are rarely collected with Malaise traps, the much used and standardized method for collecting Sciaroidea flies, although Fitzgerald (2019) lists a couple records of *Rocetelion fascicola* (Coquillett, 1894) from Malaise traps in the Nearctic Region. Rather it seems that most records stem from either sweep-netting or adults trapped or photographed at windows (Fitzgerald 2019, GBIF records and associated images). So was even the case in the present study. Considering this it might be questioned if the species is overlooked in Norway and more common than the few records restricted to the southwestern parts in Rogaland and Vestland reflect.

The question how restricted in distribution, rare and threatened *Rocetelion humerale* is in Norway further depends on how one interprets the scarce information we have on its larval habitat preferences. Seen isolated the Norwegian records, including the new data on larval habitat presented here, suggests exclusive occurrence associated with unusually large decaying logs of broad-leaved trees, specifically beech which in Norway certainly is a scarce and restricted resource. It was on this background, although before the larvae were found, the species was redlisted as endangered in Norway (Gammelmo *et al.* 2021).

Seminatural beech forest dating back some 1500 years are found only in a restricted area in south-eastern parts of Norway, near Larvik and at a small, isolated site near Bergen. In addition, beech trees have been planted many other places along the southern and western coast north to Bergen the last few hundred years, at a few places even north to Steigen in Nordland, and beech have spread from these planted trees in much of its current distribution.

The scarce information about larval habitat for *Rocetelion* that exists from other parts of the world paints a slightly different picture. Chandler (1992) suggested that the biology of *Rocetelion* may be similar to the related genera *Cerotelion* Rondani, 1856 and *Keroplatus*. This led Fitzgerald (2019) to suggest, absent hard evidence, that *Rocetelion fasciola* was associated to a woody polypore in Oregon. From the data available now it appears that while larvae of *Keroplatus* are mainly restricted to the underside of polypores (see e.g. Fang *et al.* 2018), larvae of *Cerotelion* live more in association with resupinate crust fungi (see Mantič *et al.* 2020) more like *Rocetelion*. A rearing record of *Rocetelion humerale* from a birch log infested with resupinate crust fungi in Scotland were reported by Horsfield (2000), and this makes it possible for a much wider distribution of the species in Norway, like demonstrated by the record of an adult from birch forest as far north as Abisko in Sweden. The question remains if these records represent extreme deviations from the species' normal core-habitat in more southern and warmer, broad-leaved forests.

The new data on its biology strengthens the redlist evaluation of *Rocetelion humerale* as endangered (EN) when judged isolated in a Norwegian context and underscores the importance of leaving huge, windfallen logs of broadleaved trees to decay without cleaning up by removing them, especially in semi-park and park landscapes. An increasing practice in Sweden, so far rarely seen in Norway, is to create artificial fauna depots with piles of dead wood to increase the amount and quality of habitats for saproxylic insects. Studies on the effects of such fauna depots has demonstrated that species diversity of saproxylic beetles is positively correlated with log diameter and stage of decomposition, while sun exposure and number of logs aggregated were not correlated (Selberg 2019). For saproxylic keroplatids (and Sciaroidea in general) it is likely to expect similar correlations and further a negative correlation to sun exposure. Many records of larvae belonging to large keroplatids actually stems from city parks (own records), cemetery parks (Mielczarek 2014) and similar park landscapes with stands of large and old broad-leaved threes (Falk & Chandler 2005), this indicating that such semi-natural habitats play a significant role for the survival of saproxylic keroplatids as replacements for lost natural habitats with similar qualities. To create favourable breeding habitats for *Rocetelion humerale,* and allied species with a similar biology, a practise to create fauna depots consisting of large logs placed in shady environments should be encouraged, both in park landscapes and other seminatural environments in Norway.

Due to the little descriptive work done on larvae of keropaltids, alike Sciaroidea in general, we have often few morphological clues to which species a larva belongs to when it is collected. Only a few representatives of some genera have so far been described in detail (e.g., Madwar 1937) and rearing them was previously the only way to associate the larvae to Linnean names by identifying the reared adults. Now when the Nordic reference archive on BOLD is near complete for several of the Sciaroidea families (Kjærandsen 2022), DNA barcoding gives new opportunities for associating larvae to adults without having to rear them. This has been tested with success for some 350 specimens of Sciaroidea from Norway, resulting in associations to nearly 100 different Sciaroidea species in the reference archive on BOLD. To demonstrate the efficiency of this method an ID-tree from BOLD was constructed with representatives for allied larger keroplatid species that the larvae from this study potentially could belong to, together with the barcoded larvae (Figure 7, dataset doi: dx.doi.org/10.5883/DS-ROCET). The represented species are *Platyura marginata* Meigen, 1804 of subfamily Platyurinae and from subfamily Keroplatinae: *Asindulum nigrum* Latreille, 1805, *Cerotelion striatum* (Gmelin, 1790), *Isoneuromyia semirufa* (Meigen,

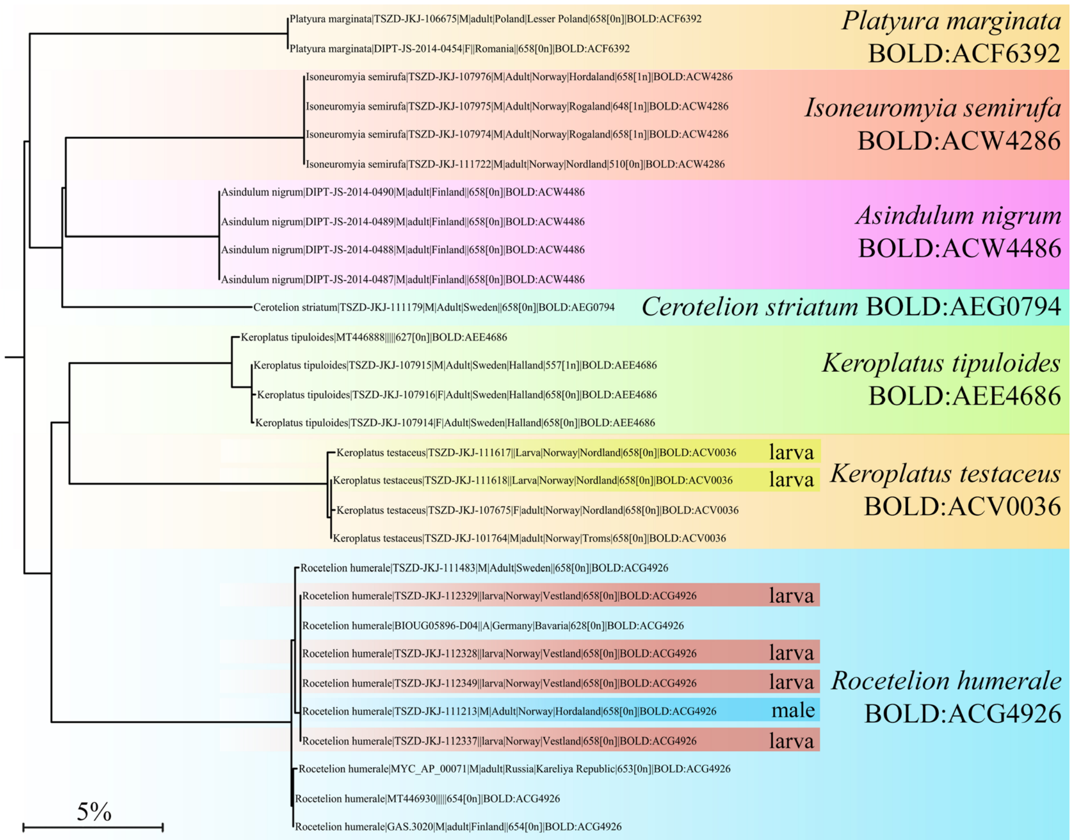

FIGURE 7. Subsection of ID-tree (Kimura-2-distance) obtained from BOLD with 29 sequences and BIN assignments for *Rocetelion humerale* (Zetterstedt, 1850) and allied large species of Keroplatidae from the Nordic Region that the larvae potentially could belong to. The species are *Platyura marginata* Meigen, 1804 of subfamily Platyurinae and from subfamily Keroplatinae: *Asindulum nigrum* Latreille, 1805, *Cerotelion striatum* (Gmelin, 1790), *Isoneuromyia semirufa* (Meigen, 1818), *Keroplatus testaceus* (Dalman, 1818), *Keroplatus tipuloides* Bosc, 1792, and *Rocetelion humerale*. The male of *Rocetelion humerale* reported in this study (TMU, TSZD-JKJ-111213) is marked with a darker blue background, and the four associated larvae (TMU: TSZD-JKJ-112328, TSZD-JKJ-112329, TSZD-JKJ-112337, TSZD-JKJ-112349) are marked with red background. Two barcoded larvae of *Keroplatus testaceous* are also marked with yellow background. The scalebar representing 5% genetic distance reveals that there is considerable genetic distance in the barcode marker between all these genera and species.

1818), *Keroplatus testaceus* (Dalman, 1818), *Keroplatus tipuloides* Bosc, 1792 and *Rocetelion humerale.* The ID-tree clearly places the larvae in the same BIN as adults of *Rocetelion humerale*, being genetically identical to the male from the same area and reveals that there are considerable genetic distances in the barcode marker between all these genera and species.

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