



Taxonomy of the Aquatic Beetles of the Families Dryopidae and Elmidae in Egypt (Coleoptera, Polyphaga, Byrrhoidea)

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ABSTRACT

This work focused on studying the taxonomy of the two families, Dryopidae and Elmidae, with the aim of enhancing knowledge regarding their taxonomy in Egypt. Moreover, the study is primarily based on a comprehensive review of previous literature and the examination of specimens preserved in the main Egyptian Insect Reference Collections. Results showed that the Egyptian fauna of Dryopidae comprises two genera and five species, among which two species are considered doubtful. Additionally, a newly recorded species, *Dryops similaris*, is added to the Egyptian fauna. However, Elmidae constitutes two genera and two species. To assess keys to families, genera and species were constructed, providing data on species diagnosis, specimens examined, and distribution. The status of the doubtful species was also discussed.

INTRODUCTION

The water beetles of the two families, Dryopidae and Elmidae, are closely related, and they belong to superfamily Byrrhoidea under the order Coleoptera (Shepard & Sites, 2016). The superfamily Byrrhoidea encompasses the most aquatic beetles, with pupation occurring in the soil, subsequently the adults enter the water and typically do not leave it thereafter (Shepard, 2011).

The long-toed water beetles (family Dryopidae) constitute about 300 designated species worldwide which belong to 33 genera (Lobl & Smetana, 2006; Jäch & Balke, 2008). It diversifies mainly in the tropic regions, however many species favor mild regions. Many dryopid adults primarily live in water or riverine environments; on the other hand, the immatures are commonly land-dwelling or semi-aquatic, occupying damp decaying wood, leaf litter and moist soil (Hayashi & Kadowaki, 2008; Jung & Bae, 2014). Furthermore, some genera of family Dryopidae are found in forestry leaf litter (Shepard, 2016).

The family Elmidae (Curtis, 1830), known as riffle beetles, comprises 1,500 species under 149 genera, and is divided into the two subfamilies: Elminae Curtis, 1830 and Larainae (LeConte, 1861). It has global distribution and is the fourth greatest

spacious family amongst water beetles (**Slipinski *et al.*, 2011**; **Jäch & Balke, 2008**). The larvae are aquatic and frequently co-occur with adults (**Shepard, 2000**; **Shepard & Sites, 2016**).

Aquatic stages of the two families consume organic material such as fungal hyphae, algae, and decaying wood (**Shepard & Sites, 2016**).

Even though beetles of the two families are effective as bioindicators of the purity of water (**Garcia-Criado & Fernández-Aláez, 2001**; **Elliot, 2008**; **Mascagni & Melon, 2011**), while the knowledge on their taxonomy, biology and importance in dynamics of water ecosystems is very poor in Egypt. The major difficulties are the out-of-date classification, their small body size and their habitat (**Passos *et al.*, 2007**). Earlier, **Alfieri (1976)**, in his list of the Egyptian Coleopteran, listed four species currently belonging to the two families. While, recently, **Salah (2017)** provided a checklist to the aquatic Polyphaga of Egypt listing five species belonging to the two families, Dryopiade and Elmide.

The current work deals with the taxonomy of the two families and could be used as a root for future advances in the taxonomic knowledge of the two families in Egypt.

MATERIALS AND METHODS

Species identification and names update were based on the studies of **Brown (1981)**, **Kodada and Jäch (2005)**, **Löbl and Smetana (2006)**, **Barbosa *et al.* (2013)** and **Shepard and Sites (2016)**.

The specimens in this study were deposited in the two main Insects Reference Collections in Egypt: Ain Shams University, Faculty of Science, Department of Entomology (ASUC); Cairo University, Faculty of Science and Department of Entomology (CUC).

For male genitalia, the aedeagus was separated from the specimens and cleared in 10% KOH overnight, following the method of **Brown (1972)** and **Polizei *et al.* (2022)**. Afterward, the genitalia were examined, photographed, stored in microvial containing glycerin, and attached to the same pin as the specimen.

The examination was carried out using a LABOMED, CZM4, binocular microscope and habitus photographed by Sony Dsc-W610 digital camera, and body parts were photographed using 12 Megapixel camera 1080p, with magnification power of 50x to 1200x.

RESULTS

Key to families

- 1- Antennae very short, the last 6 or more segments forming a close pectinated club (Fig. 1A)**Dryopidae**
 - Antennae usually slender, never clubbed (Fig. 1B)**Elmidae**

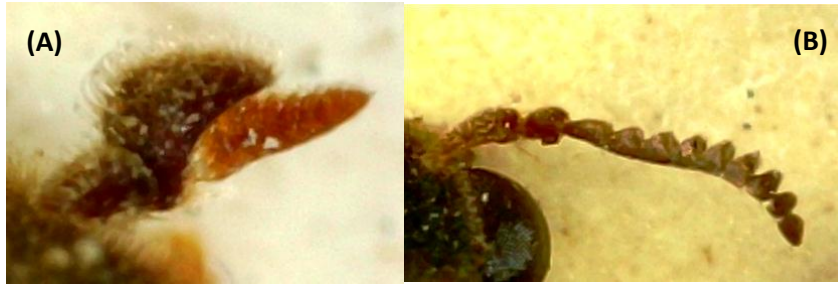


Fig. 1. (A) Antennae of *Dryops luridus* (Erichson, 1847) (Family Dryopidae), (B) Antennae of *Potamodytes subrotundatus* (Pic, 1939) (Family Elmidae)

1. Family Dryopidae Billberg, 1820

The species of the family are characterized by being small to medium-sized, with ovate to elongate bodies measuring 1.5– 8mm in length. They typically exhibit a dull grey or brown color, with the head more or less withdrawn into the thorax. Some species may have their body covered with a fine pubescence, and their antennae are very short, with most segments wider than long and hidden by the prosternal lobe.

Key to genera of family Dryopidae in Egypt

- 1- Antennae inserted on the frons from each side, with the 2nd antennal segment strongly dilated and prolonged apically in the form of a big earlet; pronotum with distinct longitudinal furrow on each side (Fig. 2A)***Dryops* Olivier, 1791**
 - Antennae inserted near lateral borders of frons, with the 2nd antennal segment not strongly dilated and forming a short, rounded earlet; pronotum without furrows along the edge (Fig. 2B)***Parahelichus* Lobl & Smetana, 2006**

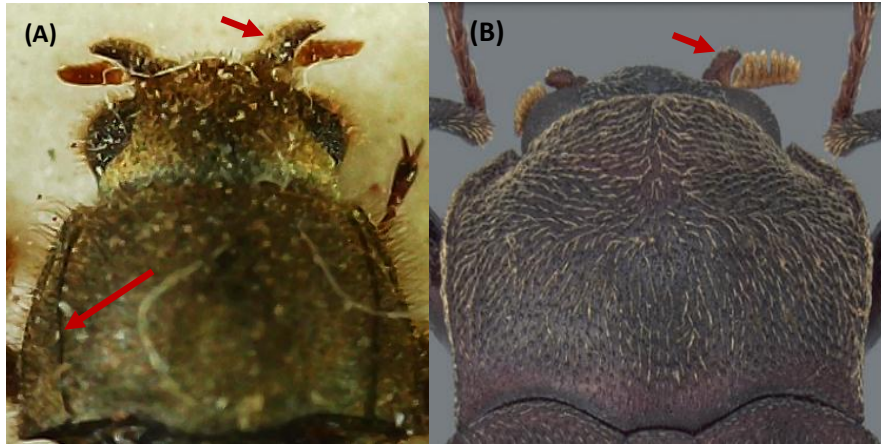


Fig. 2. (A) *Dryops luridus*, head and pronotum; (B) Head and pronotum of *Parahelichus* sp., as illustrated by Shepard and Sites (2016)

1.1. Genus *Dryops* Olivier, 1791

Diagnosis: The body elongate-oval or elongated, covered with almost scaly hair (toment) that extends over almost the entire back and abdomen; the hair includes obliquely protruding hair and very long, almost bristly hair; the eyes large, coarsely faceted, densely covered with hair; antennae consist of 9 or 10 segments, with the 1st segment short and conical, the 2nd notably large and ear-shaped, extending to a point, the 3rd segment stalked, and the basal segment of antennae forms a club, with subsequent segments short and broadened, set close together to create a spindle-shaped pointed club with a blunt sawn inside; the pronotum at the base almost the same width as the base of elytra, narrowing in front, and featuring a longitudinal groove on each side near the lateral edge, which sharp-edged on the outside.

- In Egypt, four species of genus *Dryops*, including a newly recorded species, have been identified.

Key to the species of genus *Dryops* in Egypt

- 1- Antennae 9 segments; pronotum fine punctuated *rufipe* (Krynicky, 1832)
- Antennae 10 segments; pronotum slightly coarser punctuated than *rufipes* **2**
- 2- The body 5 mm in length, covered with brown short hairs; the base of antennae closer to the margin of the eye than to each other, the forehead between the base of antennae rounded, not humped *gracilis* (Karsch, 1881)
- The body 3.7- 4.6 mm in length, covered with very short and thick yellowish pubescence; the base of antennae closer to one another than to the margin of the eye; the forehead between base of antennae humped **3**

- 3- The body 3.7- 4.3 mm in length, with an elongated slightly parallel side (Fig. 3A); the pronotum narrow slightly from the widest point posteriorly, tapering anteriorly more or less in a straight line, longitudinal furrows nearly straight, only weakly curved inwards at the front and back (Fig. 4A); the punctuation of pronotum differ from *similaris* (Fig. 4B), and the elytra densely covered with pubescens (Fig. 4C) *luridus* (Erichson, 1847)
- The body 4.2- 4.6 mm in length, and more robust (Fig. 3B); the pronotum widest just before the middle, with sides evenly rounded towards the anterior but only somewhat narrowed posteriorly, forming a small pointed hind angle, the pronotum occasionally weakly ridged, longitudinal furrows slightly rounded or winged, almost straight (Fig. 4D), the punctuation of pronotum differs from *luridus* (Fig. 4E); the elytra quite elongated, gradually tapering, finely punctuated, with more pubescence posteriorly (Fig. 4F) *similaris* Bollow, 1936.



Fig. 3. (A). *Dryops luridus* habitus, showing a dorsal view, **(B).** *D. similaris* habitus, showing a dorsal view

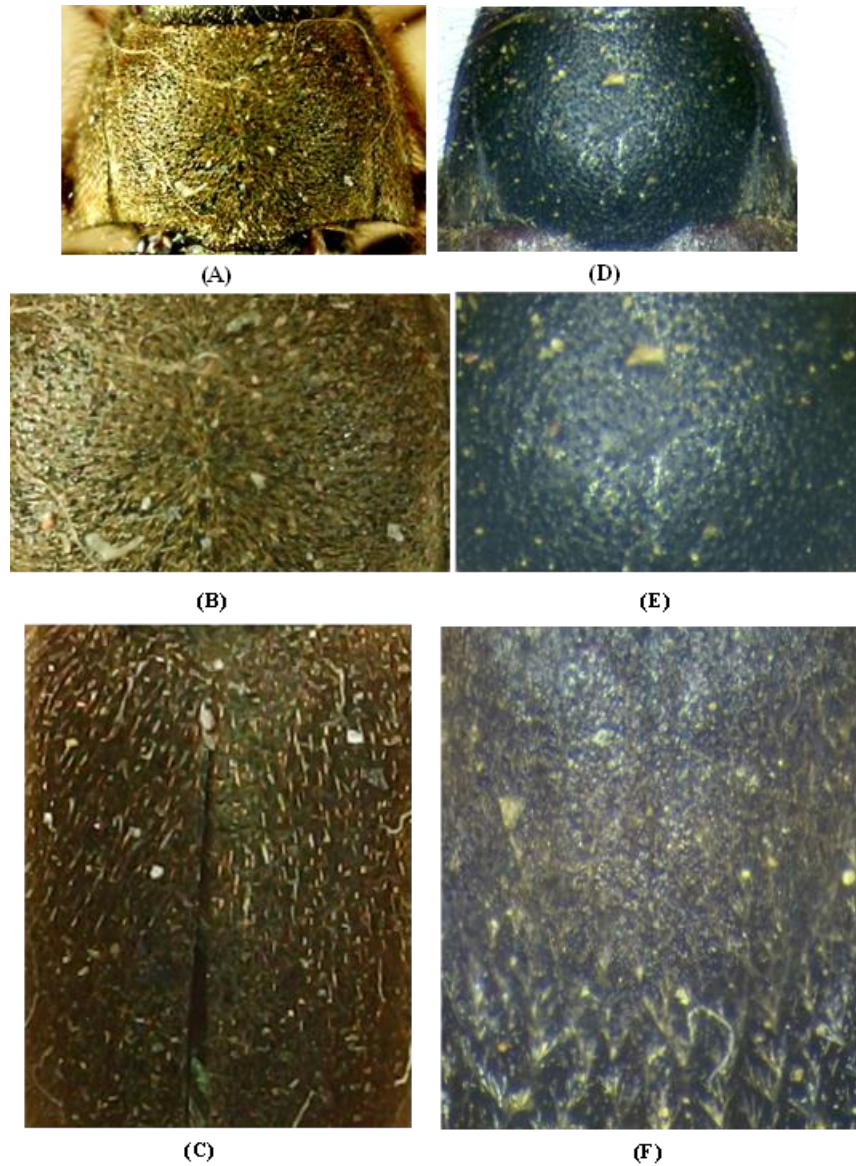


Fig. 4. A- C. *Dryops luridus*; A. Pronotum, B. Pronotum punctuation, C. Elytra punctuation. D- F. *D. similaris*; D. Pronotum, E. Pronotum punctuation, D. Elytra punctuation

1.1.1. *Dryops gracilis* (Karsch, 1881)

Parnus gracilis Karsch, 1881. Berlin. Entomol. Zeit. 25: 45.

Parnus subspoliatus Rey, 1889. L' Echange 5(49): 67.

Dryops ignotus Bollow, 1939. Mitt. Munch. Entomol. Gesellsch, 29: 121.

Dryops distinctus Bollow, 1939. Loc. cit.: 124.

Type locality: Ain Schersozura (Libya).

Diagnosis: The body 5 mm in length, characterized by an elongated form that sub-cylindrical or sub-fusiform, and of a light brown color, covered with short brown hairs; the pronotum slightly convex and little dilated towards base; the scutellum laterally rounded with a sub-acute apex; the elytra slender, slightly dilated compared to the prothoracic base, narrowing noticeably behind the middle and ending in a sub-acute apex, their margins thickened, and densely and feebly punctuated.

World distribution: Algeria, Canary Islands, Egypt, France, Greece, Italy, Morocco, Portugal, Spain and Yemen.

Material examined: There is no representative of this species in the Egyptian insect collections. The species is recorded in Egypt according to **Bollow (1938)**, **Kodada and Jäch (2006, 2016)** and **Salah (2017)**.

1.1.2. *Dryops luridus* (Erichson, 1847)

(Figs. 1A, 2A, 3A, 4 A-C, 5A, B)

Parnus luridus **Erichson, 1847**. Naturg. Insect. Deutsch. :513.

Parnus pubescens **Walker, 1871**. List of Coleoptera collected by Lord Esq in Egypt, Arabia and near the African shore of Red Sea: 11.

Parnus fulvago; fuscipes; subseriatus **Rey, 1889**. L' Echange 5 (49): 67.

Parnus intermedius **Kuwert, 1890**. Verh. Kais.-Koenig. Zool-Botan Gesel, 40: 53.

Type locality: Schlesien, Hard (Holland).

Diagnosis: The length ranges from 3.7- 4.3mm; the body tawny in color with very short and thick yellowish pubescence; the head and prothorax appear dull green; the tarsi relatively short and stocky, with segments 1- 5 of the mid tarsi significantly shorter than the tibia; the 2nd antennal segment extends to a sharp point; the pronotum only slightly narrower than the elytra, narrowing slightly towards the back and more so towards the front, almost straight, the longitudinal grooves of the pronotum almost straight, only slightly curved inwards in front and behind, the pronotum often exhibits a weak longitudinal keel.

Male genitalia: In Figs. (5A, B), the aedeagus with phallobase longer than the parameres and strongly curved laterally, the parameres slightly exceeds the apex of the penis (medial lobe), being widest at the base and narrowed in apical margin. In lateral view, each paramere almost straight and narrower than penis, with a pointed apex. The penis, in dorsal and ventral views lanceolate.

World distribution: It is widely distributed in most of Europe and North Africa including Egypt & Saudi Arabia.

Material examined: Wadi Isla, 5. VIII.1994 (10)ASUC

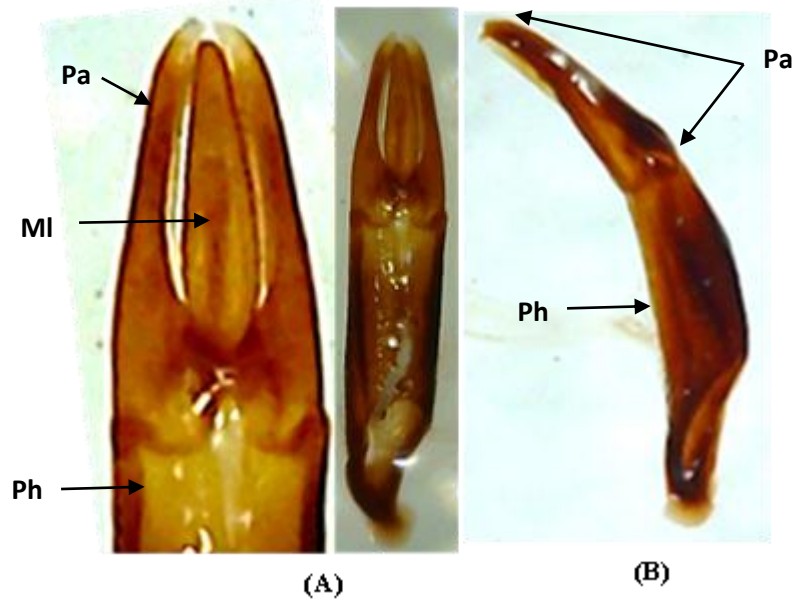


Fig. 5A- B. Aedeagus of *D. luridus* showing: (A). Dorsal view, (B) lateral view
Abbreviations. Pa: Parameres, MI: Median lobe (penis), Ph: Phallobase.

1.1.3. *Dryops rufipes* (Krynicky, 1832)

Parnus rufipes Krynicky, 1832. Bull. Soc. Imper.Natur. Moscou, 5 :115.

Parnus pilosellus Erichson, 1847. Naturg. Insect. Deutsch. :515.

Parnus puberulus Reiche-Saulcy, 1856. Ann. Soc. Entomol. Fr., 4: 368.

Parnus corsicus Kuwert, 1890. Verh. Kais.-Koenig. Zool-Botan Gesel, 40: 41.

Dryops punctatellus Bollow, 1936. Entomol Blatt, 32: 56.

Type locality: Kharkov (Ukraine).

Diagnosis:

The length 4 mm, and the width 1.3 mm; the body elongate and sub-cylindrical; the pronotum black with a grey coating and less compact, little raised grey hairs, has strong, little compact punctuation, with the intervals finely granulated; the head little swollen between the antennae, which very close at their insertion point, testaceous, with the dilatation of 2nd segment being brown; the prothorax as wide as the head, widen towards its base where it attains the width of elytra, with sides slightly rounded, posterior angles prolonged and acuminate, and its anterior border slightly notched with sharp and advanced angles; the disk very convex with little arched lateral grooves; the scutellum triangular, nearly cordiform, with denser grey pubescence; the elytra elongate and convex, with punctuation disposed in striae; the ventrum more compact down and with finer punctuation; the legs reddish.

World distribution: Afghanistan, Austria, Egypt, France, Germany, Greece, Hungary, Iran, Italy, Lebanon, Palestine, Portugal, Romania, Spain, Syria, Turkey and Uzbekistan.

Note: This species without representative specimens in the Egyptian collections. The species is mentioned in Egyptian fauna depending on the works of **Bollow (1938)**, **Olmi (1976)**, **Kodada and Jäch (2006, 2016)** and **Salah (2017)**.

1.1.4 *Dryops similaris* Bollow, 1936

(Figs. 3B, 4D- F)

Dryops omissus **Bollow, 1939**. Mitt. Mun. Entom. Ges: 354.

Type locality: Southern Russia

Diagnosis: The body 4.2- 4.6 mm in length, presenting a robust, broader, and rather short appearance, quite strongly hemispherical; the elytra have finer punctures than the pronotum; the second antennal segment tapers to a sharp point, and the segments of the club not particularly large, antennal bases relatively close to each other, with the frons projecting clearly between them; the pronotum widest just before the middle, with sides evenly rounded toward the front but only narrowing slightly toward the rear, resulting in small pointed hind angles, pronotum sometimes weakly ridged, with longitudinal furrows slightly rounded or winged, almost straight; the elytra quite elongate, gradually tapering, weakly constricted behind the shoulders, with distinct lines of punctures, particularly at the base.

Material examined: Karm Alam, South Sinai, 10.IV.1940 (3) CUC

World distribution: Austria, Croatia, Czechia, Denmark, Egypt, England, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxembourg, Spain, Sweden, Netherlands, Norway, Poland, Romania, Russia (Southern European Part, Northern European Part, Central European Part, Far East), Slovakia, Turkey.

1.2. Genus *Parahelichus* Lobl & Smetana, 2006

Diagnosis: The antennae consist of 10 segments, with the second segment more or less enlarged, the club loosely jointed, and the segments combed long; the lateral edge of pronotum lobed or bent up, with the greatest width in the middle and without protruding hind angles.

Only one species of this genus has been recorded from Egypt.

1.2.1 *Parahelichus fenyesei* (Reitter, 1894)

Dryops fenyesei **Reitter, 1894**. Wien. Entomol. Zeit. 13: 313.

Type locality: Helwan (Egypt).

Diagnosis: The length ranges from 5- 6mm; the 1st and 2nd antennal segments slightly clubbed and incrassate, with the 2nd one a little stronger, most segments yellow; the pronotum transverse, a little narrower than the elytra, with sides rounded and widened before the middle, before the shoulders, there a swelling in males with long, dense tomentous brown yellow felt; the elytra have indistinct stripes, densely punctate, and above, they bear short golden-yellow hairs; the legs rusty brown, regularly incrassate in

males, and the hind tibiae spiny, produced externally at apical angle.

World distribution: Egypt.

Note: This species is not represented in the Egyptian Collections. It is added according to the type locality in the original description of **Reitter (1894)** and also mentioned in the works of **Alfieri (1976)**, **Olmi (1976)**, **Kodada and Jäch (2006, 2016)** and **Salah (2017)**.

2. Family Elmidae Curtis, 1830

Diagnosis: Somewhat cylindrical in shape, with the elytra being very smooth or somewhat ridged and most of them 3.5- 4.5mm in length or less; the antennae filiform or slightly clubbed.

This family is represented in Egypt by two genera *Oulimnius* Gozis, 1886 and *Potamodytes* Grouvelle, 1896. Each of them includes only one species.

Key to genera of Elmidae in Egypt

- 1- Body length 2.2- 2.7 mm; pronotal disc granulated with two lateral carinae (Fig. 5A); the elytra with two sublateral carinae composed of rows of granules (Fig. 5B) ***Oulimnius* Gozis, 1886.**
- Body length 7- 8 mm; pronotum fine punctuated without a lateral carinae (Fig. 5C); the elytra have fine, irregularly punctuated intervals (Fig. 5D) ***Potamodytes* Grouvelle, 1896.**

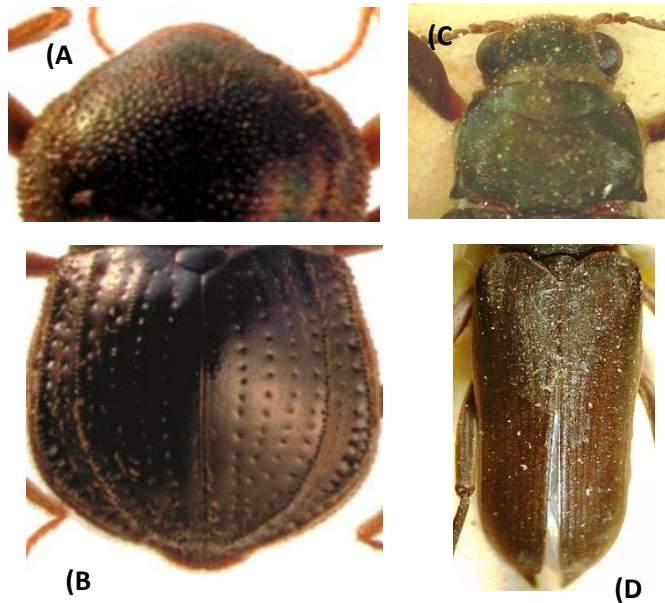


Fig. 5. A- B. *Oulimnius* (Taken after **Barbosa *et al.* 2013**), (A) Granulated pronotum, (B) Elytra showing sublateral carinae. (C- D) ***Potamodytes subrotundatus* Pic, 1939** (C) Pronotum, (D) Elytra

2.1. Genus *Oulimnius* Gozis, 1886

Diagnosis: The pronotum has 2 longitudinal keels that converge forward and not connected by a transverse keel in front of the base, enclosing a roughly trapezoidal midfield that open in front and behind, these longitudinal keels continue on the elytra as ridge-like raised spaces, the 7th interstices are less strong, and the 4th inner interstice rather flat; the pronotum base edged out in front of the relatively large, almost rounded cap; the elytra slightly widened behind the middle, tapered at back, and moderately arched, each space on the elytra has a clearly recognizable row of loose hairs, and the sides have some rows of granules, the outermost margin and a spot behind the shoulders are lighter yellowish-brown tomented.

Note: In Egypt, there is only one species belonging to this genus.

2.1.1 *Oulimnius aegyptiacus* (Kuwert, 1890)

Limnius aegyptiacus **Kuwert, 1890**. Verh. Kais.-Koenig. Zool-Botan Gesel, 40: 44.

Limnius aegyptiacus lineatus **Kuwert, 1890**. Loc. cit.: 20.

Type locality: Egypt

Diagnosis: The body length ranges from 2.2- 2.7mm; black, nearly metallic, or black brown, with white, felt-like patches on the sides; the antennae yellowish; the pronotum wider than long; the elytra not or nearly impressed from the middle, with shoulders stripes very slightly carinated; the prosternum even or slightly convex between two keels; the metasternum densely punctuated and deeply grooved posteriorly at the middle; the legs brown, with pale tarsi, and the ventrum black.

World distribution: Egypt and Morocco.

This species is not represented in the Egyptian Collections.

2.2. Genus *Potamodytes* Grouvelle, 1896

Diagnosis: The pronotum with 2 longitudinal keels, mostly converging forward and not connected by a transverse keel in front of the base; these keels enclose a slightly arched midfield that opened at the front and back, with pronotum base not emarginate in front; all interstices of the elytra uniformly slightly arched, in some larger species, the 7th space at the base somewhat stronger and forms the shoulder corners; otherwise, it always fairly flat; the elytra evenly arched, mostly in larger and stronger species.

There is only a single species of this genus recorded from the Egyptian fauna.

2.2.1 *Potamodytes subrotundatus* Pic, 1939

(Figs. 1B, 5C, D)

Potamodytes subrotundatus **Pic, 1939**. Bull. Soc. ent. Egypte, : 143.

Potamodytes ochus **Hinton, 1948**. Brit. Mus. Exped. South west Arabia: 137

Potamodytes subspinosus **Pic, 1950**. Bull. Soc. ent. Egypte, 34 : 23.

Potamodytes pici **Deleve, 1967**. Bull. Ann. Soc. Roy. Belg. Entomol. 103 :431.

Type of locality: Egypt

Diagnosis: The length 7- 8mm; the color dark and shining, with a grey-silky pubescent appearance; the antennae at the base diversely rufous, with the 1st segment testaceous, the 2nd slightly obscure, and the last segment short and narrow; the thorax rather finely but not densely punctate, with a wide impression posteriorly at the middle and obliquely impressed at the angles; the scutellum elongate and sub-triangular & punctuated; the elytra elongate, with a slight entanglement at the middle, and the elytral apex separately sub-rounded, unarmed or slightly spinose; the disk has intervals finely irregularly punctuated; the femora at the base slightly rufescens, the tibiae rather narrow, deplanate & canaliculated; the abdominal segments diversely rufous at margins.

Material examined: Mansoura, 15.X.1956 (6) (ASUC)

World distribution: Egypt, Palestine, Saudi Arabia and Yemen.

DISCUSSION

For the first time since **Alfieri's** listed in (1976) this work provides information on the taxonomy of the two families Dryopidae and Elmidae in Egypt. The data are based on the specimens which were deposited in the main Egyptian Reference Collections as well as literature.

For Dryopidae, a newly recorded species; *Dryops similaris* was added to the Egyptian fauna depending on three specimens deposited in CUC and were misidentified as *D. luridus*. The occurrence of the two species *Dryops gracilis* and *D. rufipes* in Egypt is doubtful where the two species were firstly mentioned to be distributed in Egypt by Bollow (1938), without reporting any specimen examined. Additionally, this was followed by the next catalogues by **Kodada and Jäch (2006, 2016)** and in the list by **Salah (2017)**. Furthermore, the two species were not mentioned in the list of the Egyptian Coleoptera by **Alfieri (1976)**, and they were not represented in the two studied Egyptian Reference Collections.

For family Elmidae, two species belonging to two genera were included in this work. *Oulimnius aegyptiacus* (**Kuwert, 1890**) was added depending on its type of locality, however it was not collected since the original description by Kuwert (1890).

The current work serves as the foundation for the taxonomic knowledge of the two families in Egypt. It is imperative that the new taxonomic studies on these families are conducted, incorporating recent collections from drainage basins and aquatic habitats. This effort contribute to enhancing our knowledge on the species richness and distribution of the two families in our fauna.

ETHICAL APPROVAL

This research article was approved by the research ethics committee from the Faculty of Science, Ain Shams University with the code: ASU-SCI/ENTO/2023/10/1.

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