

**Morphology and polymorphism of *Corbicula fluminea*  
(Müller, 1774) (Mollusca : Bivalvia: Corbiculidae)  
of River Nile, Egypt**

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**ABSTRACT**

The Corbiculidae exhibits a great variations in shell-shapes and colours that make the discrimination of the bivalves of the genus in difficult, *Corbicula fluminea* and *C. fluminalis*. This study was carried out to solve this conflict. The substratum of the investigated clams is sand-gravel or sand-gravel-muddy and its water is transparent and calm.

Moreover, the morphological characters (shapes and colours) of the shells were thoroughly investigated and sorted into three groups according to shapes and colours.

Electrophoresis SDS, polyacrylamide electrophoresis gel were made on the three sorted groups and juveniles that show no differences in protein patterns as well as their scans profiles. It was concluded that all ecomorphs are belonging to one species; *C. fluminea* that collected from irrigation canal system of River Nile, Egypt.

**Key words:** Morphology, polymorphism, Bivalvia, *Corbicula fluminea*, electrophoresis, River Nile. Egypt.

**INTRODUCTION**

African freshwater bivalves seem to be a neglected animal group, perhaps they do not clear economic or medical importance. These bivalves show great variations in morphology and colours, that is coupled with relatively few constant characters, which rendered it a systematically group. The majority of the African freshwater clams belong to two superfamilies; Unionacea and Corbiculacea (Sphaeriacea). However, the family Corbiculidae is only represented by the genus *Coribucla* in Africa (Mandhal-Barth, 1988).

In Egypt, Pallary (1924) early identified three species of *Corbicula* namely: *C. zelebori*, *C. consobrina* and *C. artini* and Gardner (1932) identified four species from Faiyum lake bed, Mohamed (1987) identified one species, *C. fluminalis* from Assuit governorate and Awad (1995) described *C. fluminea* from Giza. However, Mandhal-Barth (1988) studied the taxonomy of African freshwater clams and described only *C. fluminalis* from Egypt. Recently, Bishai *et al.* (1999), Bogan (2004), and Graf and Cummings (2007) made the distribution of bivalves of family unionidae from Egypt.

In this respect, Morton (1982) has proposed a model of genus *Corbicula* and attributed this taxonomical conflict to the wide geographical and ecological

ranges of these clams. Moreover, (Morton (1982), Britton and Morton (1982) Araujo *et al.* (1993) provide a good discrimination between *C. fluminalis* and *C. fluminea*.

The Asian clam, *C. fluminea* is a rounded triangular small freshwater bivalve, with strong thick concentric sculpture, and hinged-shell of about 40 mm, with yellowish-green or light-brown colour. These molluscs inhabit clear lotic environment and bottom is muddy, sandy or gravel or all.

The shell is internally purple with three cardinal teeth at each valve (Heterodonta), with two lateral serrated teeth in the right valve and only one in the left valve (Morten, 1977; Awad, 1995). Moreover, Korniushev (2004) made a taxonomical and anatomical revisions to Corbiculidae from Africa, and Hillis and Patton (1982) and McLeod (1986) presented morphological and electrophoretic data suggesting that two species of *Corbicula* in USA, while Blalock and Herod (1999) suggested that all North American populations are *C. fluminea*, using morphometric and electrophoretic study.

*C. fluminea* shows great polymorphism in shell-shape and colour. Sinclair and Isom (1963) attributed the polymorphism in the species of *Corbicula* to wide geographical distribution, and Britton and Morton (1986) as well as Morton (1987) to ecological conditions.

Komaru and Konishi (1999) described three shell-colour types of *C. fluminea* and Ishibashi *et al.* (2003) reported two colour types of *C. fluminea*, while Lee *et al.* (2003) identified three morphotypes of *C. fluminea* from New World, as well as Qiu *et al.* (2001) collect different shell colour from China and Tiwan. Moreover, Ibrahim *et al.* (2005) give a reproductive strategy to the same species of *Corbicula* in Egypt. However, this polymorphism are common on the molluscan shells, limpets (Rao and Ganapati, 1971), *Neritina* (Murty and Rao, 1978), *Mytilus* (Newkirk, 1980), litorines (Van Marion, 1981), *Nucella* (Crothers, 1983).

This work aimed to study the habitats, morphology and polymorphism in *Corbicula* from River Nile, Egypt to solve the conflict of its taxonomy.

## MATERIALS AND METHODS

Young and adult freshwater clams, *Corbicula* spp. were collected from irrigation canals system at al-Kanater, Kalyubia Governorate. Collection was carried out by dredging the bottom with special steel mesh-net and sieved by coarse set of sieves, as well as with hands, from gravel, sandy and muddy bottoms. The irrigation canals had clear, calm running water.

The description of the clams shells, from external and internal sides, was thoroughly made, then the specimens were sorted and arranged into three ecomorphs (A, B & C), according to polymorphism of shell shapes and colours. They were photographed from two sides by a Canon Camera.

For electrophoresis study to differentiate between the three ecomorph groups as well as the juveniles, the following steps were made, according to method of Laemmli (1970):

I : Tissue preparation.

II : Sample preparation

III: SDS PAGE (SDS-Polyacrylamide gel electrophoresis).

IV: Staining of the gels.

Then, calibration curves were made for each gel (the molecular weight markers against the relative mobility for each band of the markers). The molecular weight of each band was estimated through the calibration curve by reading the relative mobility of the band against the molecular weight on the curve.

## RESULTS AND DISCUSSION

The freshwater bivalve *Corbicula fluminea* belongs to Heterodonta, Corbiculacea (Sphaeriacea) that includes Sphaeridae and Corbiculidae. The African Corbiculae includes only two species namely, *C. fluminea* and *C. fluminalis*. There are a great confusion for separating between the two species (Morton, 1977, 1979, 1982). Mohamed (1987) and Mandhal-Barth (1988) reported one species; *C. fluminalis*, in Egypt and Africa, but Awad (1995) identified *C. fluminea* from Giza, Egypt.

In Egypt, Pallary (1924) early identified three species and Gardner (1932) reported four species. To solve this confusion between the two species of *Corbicula*, our results describe the shell-shape and colour of adults and youngs (Figs. 1a&b, 3 & 4), and habitats. These specimens were collected from lotic habitats of low depth and calm stream of irrigation canal system. However, the substratum was sand-muddy and also sand muddy gravels, with transparent water.

The Shells of *C. fluminea* are small, solid in adults and more fragile in youngs, equivalve, inequilateral with a roughly triangular or oval outline. The shell has two broad distinct dorsolateral umbos. The outer layer of the shells (periostracum) are variable in colour from greenish-yellow in young specimens to dark olive-green or brown in adults. Externally, the shells have serrated sculptures due to the presence of heavy concentric lines of growth, which consist of alternating dark and light band. The shell valves are united dorsally by a thick external ligament; oipithodentic (Fig. 1b). The juvenile clams are characterized by three flashes of purple colour located centrally, anterior and posterior of the umbo of each valve, and radiate outwards. These flashes of colour enlarge progressively as the individuals grow in size until the shell-length reaches about 6 mm, where it becomes uniformly dark. The above shell characters coincide with (Morton, 1977, 1982 and Awad, 1995).

The inner surface of each shell-valve (Fig. 1b) have purple to whitish in colour. The pallial line is dark violet and continuous with distinct shallow pallial sinus.

According to Mroton (1977 and 1988), Mandhal-Barth (1988), Arauja *et al.* (1993) and Awad (1995) *C. fluminea* has three cardinal teeth at each valve and three lateral teeth of the shell, but Mohamed (1987) reported four cardinal teeth at the right and three at left valve of *Corbicula fluminalis* from Assuit Governorate. Our investigations revealed that the shell is heterodont, bearing a number of hinge teeth (Cardinal and lateral teeth) in each valve. The cardinal teeth are three on each valve, interlocked with the other teeth of other shell valve. The lateral teeth of the right shell valve extend down as two pairs of long anterior and posterior. The two antero-lateral teeth are found, one above the other, and separated from each other by an elongated narrow groove, in which the upper lateral teeth of the opposite shell valve fits. The two postero-lateral teeth are in the form of two parallel elongated curved ridges, one above the other. They are united together anteriorly into a single short smooth tapering protrusion. They are separated from each other by an elongated narrow and shallow groove. The lower lateral teeth are elongated and transversally serrated, but the upper lateral teeth have smooth free edges. However, the left shell valve has two long, minutely serrated lateral teeth.

The present clams show a great variation in the form and colour of the shells. The collected specimens exist as three main ecomorphs; A, B and C (Figs. 2, 3 & 4).

The morph (A) is characterized by a dark-olive green in fully grown individuals and widely distributed than other colour forms. The outer surface has a heavy light and dark bands due to the lines of growth, while the juvenile has three flashes of purple colour located on each valve.

The second morph (B) is less common and nearly similar to form (A) except that the external surface is intermediate between morph (A) and (C) and the light and dark bands are absent.

The third morph (C) is much lower distributed than the other two morphs in occurrence. It is characterized by a straw-yellow or cream coloured shell. The internal surface is whitish in colour. The phenomenon of polymorphism was also noticed by Britton and Morton (1986, 1987) at north American *Corbicula* spp. and Morton (1987) from Hong Kong, but this phenomenon was also recorded in *C. fluminea* by Morton (1979) and Araujo *et al.* (1993). Moreover, the molluscans shell-form appear highly reflective of environment demands as intertidal limpets (Rao and Ganapati, 1971), *Neritina* (Murty and Rao, 1978), *Mytilus edulis* (New Kirk, 1980), Litorines (Van Marion, 1981), *Nucella* (Crothers, 1983). However, electrophoretic study was carried out by Mohamed (1987) to separate between the shells of intermediate hosts of *Schistosoma*, and Narang and Narang (1976) on *Biomphalaria glabrata* and Ishibashi *et al.* (2003) on *C. fluminea*.

The SDS polyacrylamide gel electrophoresis was carried out on the collected specimens of *C. fluminea* from Egypt to confirm that the three ecomorphs (A, B & C) are actually one species and also juveniles belonged to this species. Fractionation of the proteins of the whole body of three ecomorphs and the juvenile stage (Fig. 2) showed that only one type of protein pattern could be distinguished, as shown in Fig. 5. However, SDS polyacrylamide gel electrophoresis, was recorded the protein pattern that consists of 17 clear bands in all different forms.

The molecular weights of these bands are 101 Kd, 95 Kd, 93 Kd, 82 Kd, 79 Kd, 64.5 Kd, 61 Kd, 55 Kd, 50 Kd, 47 Kd, 42 Kd, 39 Kd, 37 Kd, 34 Kd, 32.5 Kd, 30.5 Kd and 30 Kd, respectively from cathode to anode. However, the different bivalves with different sizes and colours as well as youngs did not show any differences in their banding patterns.

For more confirmation, the polyacrylamide gels were scanned with gel scanner (Fig. 6a,b,c&j) and from obtained scans, it can be noticed that the four scans (3 for adults and one for young) for the four different protein patterns that shown in Fig. 5, are greatly similar, showing almost the same number of peaks representing the major protein almost the same number of peaks representing the bands for each sample.

Morphology, habitats and electrophoresis of ecomorph A, B & C and J (juveniles) proved that all collected clams belong to one species, *C. fluminea*.

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