ISSN 1110-0354
Bull. Nat. Inst. Of Oceanogr. & Fish., A.R.E., 2000. Vol. (26): 149 - 166

BENTHIC COMMUNITIES IN THE NILE RIVER, EGYPT II- MOLLUSCA

By

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Key words: Ecology, Taxonomy, Mollusca, Nile River.

ABSTRACT

The present work is the second in a series titled " Benthic communities in the Nile River, Egypt". It is the first work to deal quantitatively with the ecology of the Egyptian Nile Mollusca in an area extending for 805 km. between Esna and Delta Barrage (El Kanater El Khyria).

Monthly samples were collected from 9 localities selected along the Nile stream to represent different ecological conditions.

Twenty species of molluscan fauna belonging to eighteen genera affiliating to 13 families and three orders were recorded through the present study. Fourteen of them are gastropods while the other six species are bivalves.

The bivalve *Corbicula consobrina* was the most abundant species and its Absolute Importance Value (AIV) showed a peak in spring and winter.

Type of sediment was the main factor affecting AIV in the area investigated. Sandy mud or muddy sand bottom sustained populations of molluscs more than the sandy or gravely sand bottom.

The biological quality parameter ($\bar{H}$) indicates that the bottoms of Esna, Delta Barrage and Nage Hamady are localities with intermediate pollution, while the bottoms of the other investigated localities are heavily polluted. At the same time $\bar{H}$ indicates that, except at Helwan, Nile water is clean.

More investigations are needed to understand the exact factors affecting the patterns of distribution of Mollusca in the Nile, especially after forcing the EEAA law no.4 for the year 1994.

The present work is hoped to be a contribution to the achievement of a data base necessary for the planing and integrated management for a sustainable exploitation of the Nile resources.

INTRODUCTION

In spite of its very small discharge, Nile plays an important role in the life of Egypt and it provides Egypt with 98% of its water supply (Said,1981) and 44.73% of its annual fish production (9.86% wild fisheries and 34.87% from fish farming) (GAFRD, 1999). Although benthic Mollusca plays important sanitary and dietary roles in the fresh water ecosystem, few are the studies dealing with the benthic molluscs in the Nile system. According to available literature, the freshwater molluscs in the Nile system were generally investigated by Cailliaud (1826), Bourguignat (1890), Piersanti (1940), Bacci (1951/1952), Markowski (1953), Mandahl-Barth (1954; 1988), Brown (1965; 1980; 1983), Williams and Hunter (1968), Monakov (1969), Berrie (1970), Brown, ***et al.*** (1984) and Van Damme (1984; 1988). In Egypt, Olivier (1804) recorded five fresh water snails from lower Egypt, Savigny (1809) (*c.f.* Ibrahim, ***et al.***, 1999) recorded the molluscan species collected during Napoleon's Campaign to Egypt, Jickeli (1874) made a monograph of freshwater molluscs in lower Egypt and Ethiopia, Leiper (1916) recorded some snails from different localities in Egypt, Pallary (1909 and 1924) mentioned some Nile water molluscs , Abdel-Aal (1979) studied freshwater gastropods in El-Mansoura District, Menshawy (1998) (*c.f.* Ibrahim, ***et al.***, 1999) conducted a thorough survey on the freshwater molluscs in the irrigation system, Ibrahim, ***et al.*** (1999) performed a taxonomic study of freshwater molluscs of various water bodies in Egypt. In addition to the above mentioned investigations, Mollusca was included in benthic fauna studies in the Egyptian Nile and Nasser Lake (Ishak, ***et al.***, 1976; Anon ,1979; Iskaros, 1988; 1993; Fishar 1995 and Abdel-Salam, 1995).

The present work is the second in a series titled " Benthic communities in the Nile River, Egypt", the first dealt with aquatic stages of Insecta (Ramadan, ***et al.***, 1998 b). It is the first work to deal quantitatively with the ecology of the Egyptian Nile Mollusca in an area extending for 805 km between Esna and Delta Barrage (El Kanater El Khyria).

As in Ramadan, ***et al.*** (1998 b) the index of Absolute Importance Value (AIV), which pools the population density, biomass and the frequency of the taxa in one value, was used in the present study to give a true indication of the standing crop of the molluscan fauna (*i.e.* to avoid the false indication when comparing a population having plenty of small light individuals with a population represented by few massive individuals).

For a sustainable exploitation of the Nile resources, a data base is necessary for the planing and integrated management. The present work is hoped to be a contribution to the achievement of this target.

MATERIAL AND METHODS

Monthly samples were collected by Ekman grab (jaw area 15cm x15cm) from 9 localities selected along the Nile stream to represent different ecological conditions (Fig. 1 and Table 1). For the statistical confidence, three and six samples were respectively hauled from each sampling locality during February to May 1991 and from June 1991 to January 1992. For qualitative purpose, a naturalist rectangular dredge (40cm width, 25cm height and 400 μm net mesh size) was used to collect the species escaped the grab. More over, a grab sample for the sediment analysis was once hauled from each station. The physicochemical variables of each locality were measured (Table 1). Except the samples for sediment analysis , each sample was washed in the field through a net (400 μm mesh size) and the residues of each sample were preserved in a labeled jar with 10% formalin. In the laboratory, each sample was rewashed using tap water and the animals were sorted under a zoom stereo microscope (20 X).The empty shells were not considered and only the shells with individual

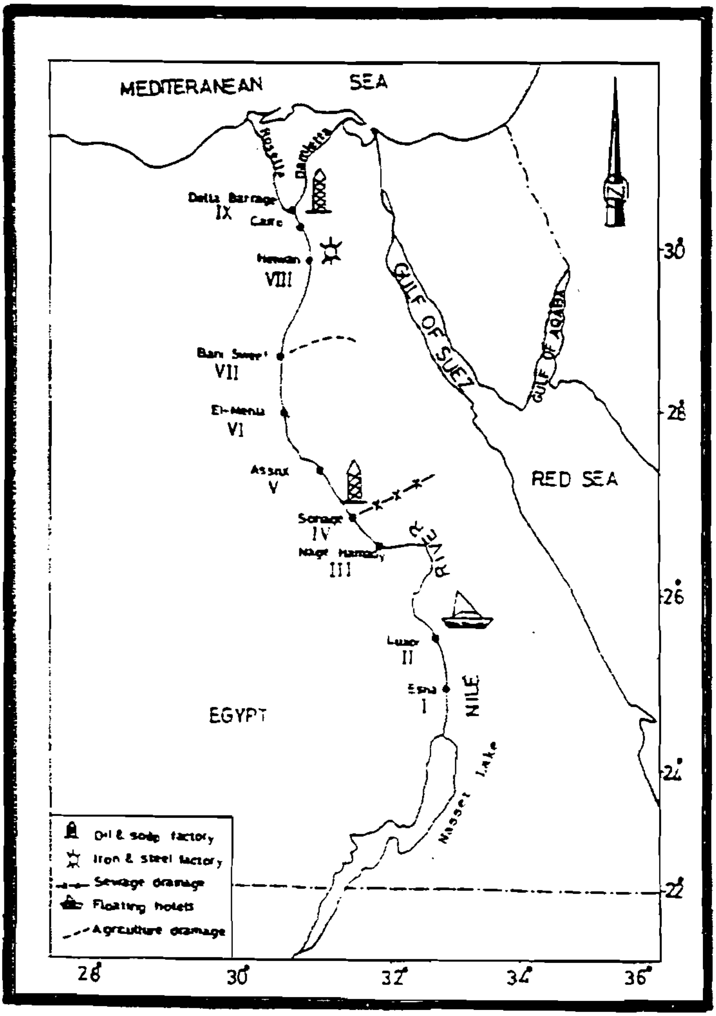

Fig. (1): A map of the study area showing the sampled localities.

inside were identified , counted and freshly weighed after removing the excessive water by using filter paper. The whole organism (without removing the shell) was weighed. For quantitative analysis only the grab samples were considered. The following literature were consulted for identification and ordering the taxa in their taxonomic position : Gardner (1932); Pennak (1953); Edmondson (1959); Brown (1980) and Ibrahim, ***et al.*** (1999).

Table (1): Sampled localities and their physicochemical variables [St. = Station; DA= Distance from Aswan High Dam (km.); W D = Water depth (m); IH = Impact of human activities (DW = Domestic waste; IW = Industrial waste; AD = Agriculture drainage); TW = Transparency of water (cm); TS= Total solids (mg. l^{-1}); O2 = Oxygen saturation percent; NO3 = Nitrate (μg. l^{-1}); PO4 = Phosphate (μg. l^{-1}); EC = Electric conductivity (μ mhos); TB = Type of bottom (S= Sandy; GS = Gravely sand; MS= Muddy sand; SM = Sandy mud); * = c.f. Elewa, *et al.* (1995)].

St.	DA	WD	IH	TW	TS*	O_2	PH	NO_3*	PO_4*	EC*	TB
I	155	2.9(Oct.)-6.5(June)	DW	159	187	106	8.1	307	110	241	S
II	210	2.3(Oct.)-7.75(May)	DW	136	190	107	8.1	328	124	244	GS
III	335	4.3(Aug.)-7(June)	IW	125	201	109	8.3	226	116	248	MS
IV	425	1.65(Oct.)-7.9(June)	IW	105	222	113	8.1	256	133	262	S
V	515	2.25(Sep.)-6(June)	IW	110	224	108	8.2	279	128	259	S
VI	640	2.2(Sep.)-6.3(May)	DW	88	231	99.8	8.2	195	147	257	S
VII	760	2.7(Sep.)-7.25(June)	AD	88	222	103	8.3	173	156	298	S
VIII	900	2(Jan.)-4.3(Mar.)	IW	80	236	99.9	8.3	191	159	299	MS
IX	960	2.8(Jan)-5.5(June &Nov.)	IW+AD	91	245	81.8	8.1	132	197	319	SM

Data of population density (PD) as individuals/m^2, biomass (BM) as g./ m^2 and absolute frequency (AF) as percentage of occurrence of a taxon in the sampling units were synthesized into absolute importance value (AIV) index as proposed by Ghabbour and Shakir (1980) and applied by Khierallah (1986;1992) and Ramadan, *et al.* (1998 b) . For the calculation of AIV, the three basic variables (PD, BM and AF) of each taxon were multiplied and logged. The Shannon-Wiener index of diversity ($\bar{H}$) (Shannon and Wiener,1963), the evenness (E) according to Pielou's (1966) equation and species richness (SR) according to Marglef's (1968) equation were calculated.

RESULTS AND DISCUSSION

Species recorded:

Twenty species of molluscan fauna belonging to eighteen genera affiliating to 13 families and three orders were recorded through the present study. Fourteen of them are gastropods while the other six species are bivalves (see list of the species recorded). All the recorded species were hauled by the grab, except *Lanistes* sp. and the bivalve *Eupera ferruginea* (Krauss, 1848) which were collected by the dredge.

List of the species recorded

(* = appeared only in dredge sample at St. IX)

PHYLUM MOLLUSCA
CLASS: GASTROPODA
SUBCLASS: STREPTONEURA (PROSOBRANCHIA)
ORDER: MESOGASTROPODA

Family: Neritidae

Theodoxus (Neritaea) niloticus (Reeve, 1856)(Plate I, A)

Family: Viviparidae

Bellamya unicolor (Olivier, 1804) (Plate I, B)

Family: Ampullariidae

Lanistes carinatus (Olivier, 1804) (Plate I, C)
**Lanistes* sp. (Plate I, D)

Family: Valvatidae

Valvata nilotica Jickeli, 1874 (Plate I, H)

Family: Bithyniidae

Gabbiella senaariensis (Küster, 1852) (Plate I, E)

Family: Thiaridae (Melaniidae)

Melanoides tuberculata (Müller, 1774) (Plate I, F)
Cleopatra bulimoides (Olivier, 1804) (Plate I, G)

SUBCLASS: EUTHYNEURA (PULMONATA)
ORDER: BASOMMATOPHORA

Family: Lymnaeidae

Lymnaea sp.

Family: Planorbidae

Subfamily: Planorbina

Helisoma duryi (Wetherby,1879) (Plate I, I)

Biomphalaria alexandrina (Ehrenberg,1831)

Subfamily: Bulininae

Bulinus (*Isidora*) *truncatus* (Audouin,1827) (Plate I, J)

Family: Physidae

Physa acuta Draparnaud,1805 (Plate I, K)

Family: Ancylidae

Ferrissia clessiniana (Jickeli,1882) (Plate I, L)

CLASS: PELECYPODA (BIVALVIA)

ORDER: EULAMELLIBRANCHIATA

Family: Unionidae

Caelatura (*Caelatura*) *aegyptiaca* (Cailliaud,1827) (Plate II, E)

Caelatura (*Nitia*) *teretiuscula* (Philippi,1847)(Plate II, F)

Family: Corbiculidae

Corbicula consobrina (Cailliaud,1827) (Plate II, A)

Family: Sphaeriidae

Sphaerium sp. (Plate II, B)

Pisidium pirothi Jickeli,1881 (Plate II, C)

**Eupera ferruginea* (Krauss,1848) (Plate II, D)

Table 2 and figure 2 show that the bivalve *Corbicula consobrina* was the most abundant species. It was represented in the whole sampled localities and formed respectively 47.7% and 74.4% of the total population density and biomass of Mollusca in the investigated area. This agrees with Iskaros (1988) who mentioned that this species appeared mostly at the offshore areas of both Aswan Reservoir and the Nile River where it contributed respectively about 58.1% and 86.1% to the PD and biomass of the total molluscs at Aswan Reservoir. As well as it agrees with Samaan ***et al.*** (1989) who stated that *Corbicula* formed the major bulk of benthos biomass in the middle of Burollus Lake.

Table (2): Species composition, distribution and biological quality parameters of mollusc population in the sampled localities during the whole period of investigation (PD= population density, N= total number of species, H= index of species diversity, E= eveness, SR= species richness, Av. = Average).

STATION / SPECIES	I	II	III	IV	V	VI	VII	VIII	IX	AV.	%
Theodoxus (Neritaea) niloticus	8	0	1	1	0.5	0	0	2	4	1.833	0.31
Bellamya unicolor	0	0	3	0	0	0	0	0.5	340	38.167	6.45
Lanistes carinatus	0	0	0.5	0	0	0	0	0	1	0.167	0.03
Valvata nilotica	0	0	52	1	0	0	0	0.5	403	50.722	8.57
Gabbiella senaariensis	29	0	32	0	2.5	0	0	0	162	25.056	4.24
Melanoides tuberculata	36	4	113	3	72	0	0	22	263	57	9.64
Cleopatra bulimoides	9	0.5	13	0	4	0	0	2	74	11.389	1.925
Lymnaea sp.	0	0	1	0	0	0	0	0	0	0.111	0.02
Helisoma duryi	0	0	1	0	0	0	0	0	0.5	0.167	0.028
Biomphalaria alexandrina	0	0	4	0	0	0	0	0	0.5	0.5	0.85
Bulinus(Isodora) truncatus	2	0	10	0	0.5	0	1	0	6	2.167	0.366
Physa acuta	0	0	6	0	0	0	0	0	1	0.778	0.132
Ferrissia clessiniana	2	0	3	0	0	0	0	0.5	23	3.167	0..535
Caelatura(Caelatura) aegyptiaca	5	0	39	0	0.5	0	0	0	191	26.167	4.423
Caelatura (Nitia) teretiuscula	1	0	1	0	2	0.5	0	0	14	2.056	0.169
Corbicula consobrina	199	21	826	27	318	11	28	135	975	28.2222	47.708
Sphaerium sp.	16	0	48	0.5	0	0	0	0	541	67.278	11.373
Pisidium pirothi	29	0	2	0	6	0	1	0	163	22.333	3.775
PD	336	26	1156	33	406	12	30	163	3162	591.556	
N	11	3	18	5	9	2	3	7	17	8.333	
H	2.084	0.761	1.675	0.941	0.993	0.258	0.42	0.846	2.921	1.211	
E	0.602	0.48	0.402	0.405	0.313	0.258	0.265	0.301	0.715	0.416	
SR	1.719	0.618	2.411	1.149	1.332	0.409	0.588	1.179	1.985	1.266	

The growth and reproduction of molluscs are apparently related to both available food supply (Pringle and Msangi, 1961) and water temperature (Brown, 1980). The temporal variation of AIV of *Corbicula consobrina* showed a peak in spring (May) and winter (December and January) (Fig. 3). This coincides with the finding of Iskaros (1993) that the number of molluscs increased gradually throughout winter and spring , reaching a peak in May/ or June. This is mainly related to the increased fecundity of individuals. Iskaros (1988) reported that *Corbicula fluminalis* reached its highest density at the offshore Nile station during February and May and few individuals appeared also at the littoral Nile station during one month or the other, attaining a maximum population density during April.

Absolute importance value (AIV) of the molluscan populations:

In the present study, there are different factors which may control the AIV. The highest values of AIV were recorded at stations IX, III, V and I, while the minimum value was estimated at station VI (Table 3 and Fig. 2).

Type of sediment was the main factor affecting AIV in the area investigated. Sandy mud or muddy sand bottom of stations IX and III sustained populations of molluscs more than the sandy or gravely sand of stations IV, VII, II and VI. This agrees with Jewell (1922) who reported that the distribution of mussels is related to substrate type and with Ishak, *et al*. (1976) who revealed that muddy bottom sustained more benthos than sandy or rocky bottoms. As well as, it agrees with Cohen (1986) who concluded that sandy bottoms are generally devoid of benthos at all water depths and Ramadan, *et al*. (1998) who advocated that the distribution of benthic insect larvae in the same area of the present investigation is mostly related to the type of bottom sediment. More over, McCall and Soster (1990) mentioned that the benthos is directly influenced by the deposited food content, substratum stability, and overlying water turbidity.

The maximum AIV at station IX (8.38) may also be attributed, beside the sandy mud nature of the bottom, to the high percentage of organic matter in the sediment due to the organic waste inflow from the Soap Factory (Awad, 1993). This result agrees with Iskaros (1993) who mentioned that the average values of organic carbon , organic phosphorus and inorganic phosphorus are generally higher in the offshore sediments than those of littorals. That is due to the fine texture of the offshore sediments which can sustain high content of those elements. The high AIV estimated at station III (7.79) may also be attributed, in addition to the muddy sand nature of bottom, to the presence of sustainable plant detritus. This deduction is in accordance with Egglishaw (1964) who showed a correlation between abundance of benthic fauna and the increase in detritus availability.

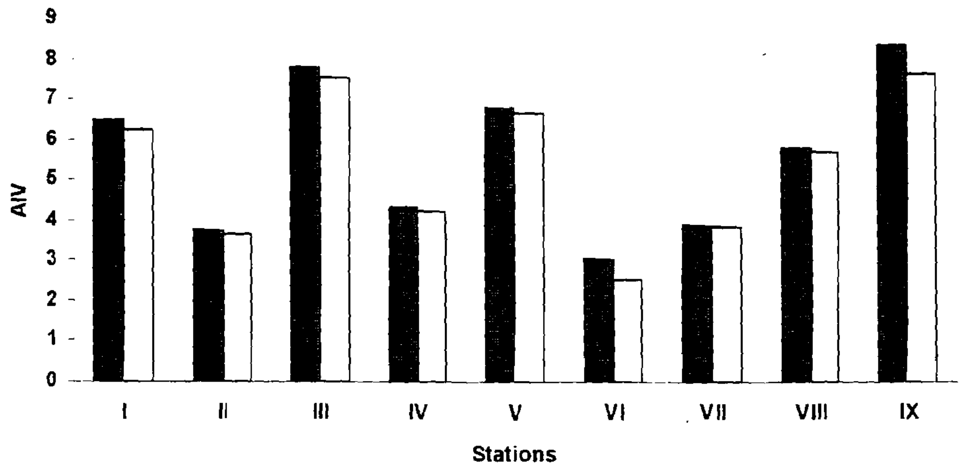

Figure (2): Monthely average of Absolute Importance Value (AIV) of total molluscs (Series 1) and *Corbicula consobrina* (Series 2) at the investigated localities.

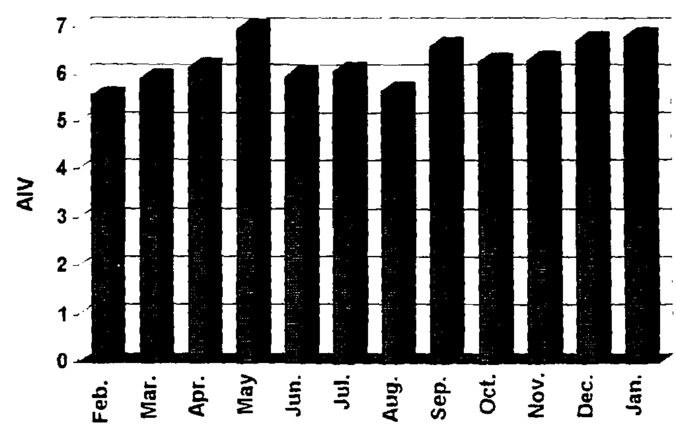

Figure (3): Monthly variation of Absolute Importance Value (AIV) of *Corbicula consobrina* for the whole area of investigation.

Table (3): Monthly average of Population Density (PD), Biomass (BM), Absolute Frequency (AF) and Absolute Importance Value (AIV = log PD x BM x AF) of total mollusc population at each sampling locality.

Station	*PD*	*BM*	*AF*	*AIV*
I (Esna)	336	161.23	55.5	6.47
II (Luxor)	26	10.54	20.7	3.75
III (Nage Hamady)	1156	556.37	95.8	7.79
IV (Sohag)	33	19.17	34.61	4.34
V (Assuit)	406	216.424	76.30	6.82
VI (El-Menia)	12	4.92	19.30	3.05
VII (Bani Sweef)	30	8.93	29.10	3.89
VIII (Helwan)	163	63.85	58.30	5.78
IX (Delta barrage)	3162	823.60	93.04	8.38

The appreciable AIV estimated at stations V and I (6.82 and 6.47 respectively) may be attributed to the low water current at station V due to the Assiut barrage, a condition which represents the pool of stream, and the low degree of pollution at station I. Wilhm and Dorris (1968) said that the unpolluted streams exhibit an increased number of species. On the other hand, McCulloch (1986) reported that pools supported a more diverse benthic fauna.

Although station VIII has a muddy sand bottom, it sustained a relative low population of Mollusca (AIV =5. 78). This may be attributed to the high degree of pollution with heavy metals (Fe^{2-}, Cu^{2-}, Zn^{2-} and Mn^{2-}) where many industrial pollutants resulting from the industries of iron, steel, fire bricks, cement and chemicals which discharge directly into the Nile water (Ali, ***et al.***, 1992). The minimal AIV estimated at stations II and VI (3.75 and 3.05, respectively) could reflect the nature of the bottoms which are gravely sand and sandy respectively, together with the fact that station II is a dock for the tourist ships which always cause water disturbance and pollution, and station VI is affected by industrial wastes. Samaan and Aleem (1972) reported that the highly polluted area is extremely poor in bottom animals.

Biological quality parameters:

Regarding the biological quality parameters (Table 2), the present results show that the highest estimations of H and E occur at stations IX and I, while the lowest estimations of $\bar{H}$, E and SR occur at stations VII and VI. The highest value of $\bar{H}$ can be attributed to the low water current at station IX and the low degree of pollution at station I. Dean and Burlington (1963) indicated that unpolluted localities had a diverse macrobenthic invertebrate populations as compared with the polluted localities.

The appreciable $\bar{H}$ estimated at station III can be attributed to the available plant detritus at bottom sediment. Egglishaw (1964) indicated that increases in plant detritus have been correlated with an increase in the variety of the bottom fauna. So, the species diversity (18 species) and species richness (2.41) in this station are higher than those in stations IX and I where N= 17 and 11 spp., respectively and SR= 1098 and 1072, respectively, while the lowest values of $\bar{H}$, E and SR demonstrate the sandy nature of the bottom sediment at stations VII and VI.

Applying the suggestion of Wilhm (1972) indicates that the bottoms of stations I, IX and III, where $3 > \bar{H} > 1$, are localities with intermediate pollution, while the bottoms of the other investigated localities, where $\bar{H} < 1$, are heavily polluted. Except the case in station III, the present results agree with those of aquatic stages of insects (Ramadan, *et al.*,1998 b). The slight difference between $\bar{H}$ of Mollusca and $\bar{H}$ of aquatic stages of insects at station III may be attributed to the difference of population. Accordingly, it is better to apply Wilhm's (1972) suggestion on the whole benthic invertebrate community.

Applying the Wilhm's (1972) suggestion on the results of zooplankton community in the same area during the same period (Ramadan, *et al.*, 1998 a) revealed that the Nile water is clean except at Helwan where it was intermediately polluted. That indicates that pollution has more influence on macrobenthic invertebrates than on zooplankton community.

However, the material of the present investigation were collected before the issue of the Egyptian Environmental Affairs Agency (EEAA) law no.4 for the year 1994. Accordingly, more investigations are needed to understand the exact factors affecting the patterns of distribution of Mollusca in the Nile, especially after forcing the law.

PLATE II Each division = 1 mm.

PLATE I Each division = 1 mm.

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