VIE ET MILIEU, 1999, 49 (1) : 11-17

NEW CEPHALOPOD MOLLUSCS IN THE EASTERN MEDITERRANEAN : PREVIOUSLY UNNOTED SPECIES OR RECENT MIGRANTS ?

A. SALMAN, T. KATAGAN* & S. v. BOLETZKY***

** Ege University, Science Faculty, Department of Biology, Section of Hydrobiology, 35100 Bornova-Izmir, Turkey*
*** Observatoire Océanologique de Banyuls, UMR 7628, Laboratoire Arago, BP 44, 66651 Banyuls-sur-Mer, France*

CEPHALOPODA
OCTOPUS CF. *AEGINA/KAGOSHIMENSIS*
OCTOPOTEUTHIS MEGAPTERA
MEDITERRANEAN
IMMIGRATION

ABSTRACT. – Thirteen adult individuals of a small octopus species of the *Octopus aegina* complex, 7 males and 6 females, were caught by trawl on bottoms ranging from 60 to 70 m of depth off the southern coast of Turkey, close to Mersin. This species (which is similar to *O. kagoshimensis*) was never before recorded in the Mediterranean. Further to the West on the southern Turkish coast (Gulf of Bodrum), a single individual of a pelagic squid of the genus *Octopoteuthis* was captured. The tentative identification as *O. megaptera* is based on the body shape and the presence and position of two caudal mantle photophores ; this is the first record of this species in the Mediterranean. These observations are discussed with regard to questions of species identification and possible recent species range extensions due to immigration from the Atlantic, or from the Red Sea (Lessepsian migration).

CÉPHALOPODES
OCTOPUS CF. *AEGINA/KAGOSHIMENSIS*
OCTOPOTEUTHIS MEGAPTERA
MÉDITERRANÉE
IMMIGRATION

RÉSUMÉ. – Dans la région de Mersin (Sud de la Turquie), 13 individus adultes d'une espèce de Poulpe appartenant au complexe appelé *Octopus aegina* (7 mâles et 6 femelles) ont été capturés sur des fonds de 60 à 70 m. Cette espèce (proche de *O. kagoshimensis)* n'a pas encore été signalée en Méditerranée. Plus à l'ouest, dans le golfe de Bodrum, un petit Calmar pélagique appartenant au genre *Octopoteuthis* (très probablement *O. megaptera)*, a été capturé. Cette identification est basée essentiellement sur la forme du corps et la présence de deux photophores palléaux situés près du bord postérieur des nageoires ; il s'agit de la première signalisation de cette forme en Méditerranée. Ces observations sont discutées par rapport aux problèmes qui entourent l'identification des espèces et la reconnaissance d'éventuelles extensions des aires de répartition récentes dues à une immigration, soit à partir de l'Atlantique, soit à partir de la Mer Rouge (migration dite lessepsienne).

INTRODUCTION

The cephalopod fauna of the Mediterranean has been studied for centuries (for a review see Naef 1923, and recent revisions, e.g. Ruby & Knudsen 1972 ; Bello 1986 ; Mangold & Boletzky 1988 ; Barash & Danin 1988/89). This large body of systematic and zoogeographical information notwithstanding, additional species continue to turn up in different parts of the Mediterranean. Recent examples are the butterfly squid *Stoloteuthis leucoptera* recorded on the Italian coast (Orsi Relini & Massi 1991 ; Würtz *et al.* 1995), and the Atlantic bobtail *Sepiola atlantica* in the same area (Würtz *et al.* 1995). These finds raise the question whether the newly encountered cephalopods were long present in the Mediterranean but were not (at least officially) recognized, or whether they have only recently entered the Mediterranean through the Straits of Gibraltar or through the Suez Canal. Especially in the Levantine basin, species recorded for the first time could be newcomers from the Red Sea (so-called Lessepsian migrants).

MATERIAL AND METHODS

Octopus specimens belonging to the *Octopus aegina* species-group were obtained between 60 and 70 m of depth (Fig. 1, Stations 1-3) with a commercial bottom trawl (30 m in total length, mesh size 20 mm knot to

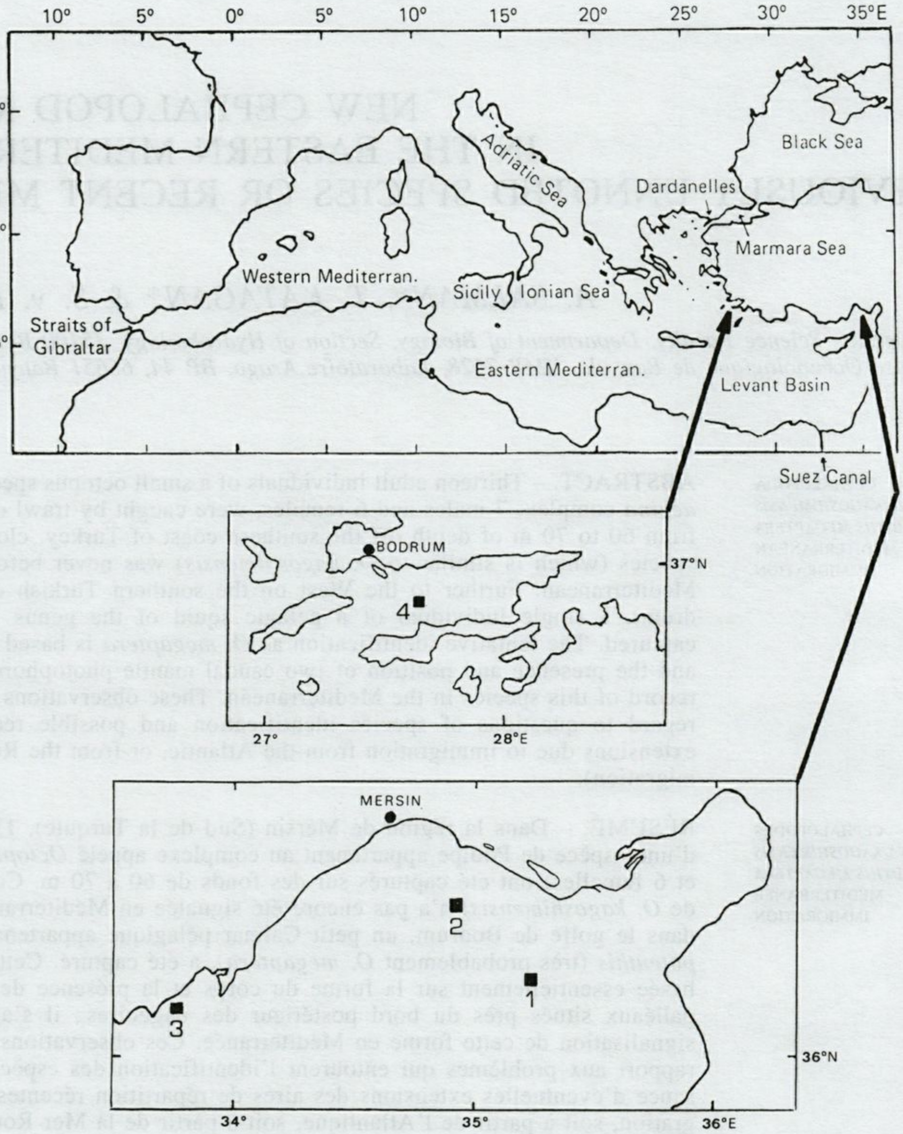

Fig. 1. – Sampling area on the South coast of Turkey. Note the relative proximity of the Suez Canal in comparison to the distance separating this coast from the Straits of Gibraltar. The larger inset map shows the three stations at which a total of 13 specimens of *Octopus* cf. *aegina/kagoshimensis* were caught (Station 1 : bottom depth (bd) 60 m, surface temperature (st) 17.9 °C, bottom temperature (bt) 15.8 °C, surface salinity (ss) 39.1 ppt, bottom salinity (bs) 39.2 ppt, haul from 36°16'0N/35°12'1E to 36°17'0N/35°12'8E. Station 2 : bd 70 m, st 17.3 °C, bt 15.7 °C, ss 39.0 ppt, bs 39.2 ppt, haul from 36°30'4N/34°55'1E to 36°31'0N/34°53'8E. Station 3 : bd 66 m, st 17.3 °C, bt 15.8 °C, ss 38.9 ppt, bs 39.2 ppt, haul from 36°08'3N/33°42'9E to 36°08'1N/33°44'4E). The smaller inset map shows the location of Station 4 where one *Octopoteuthis* sp. was caught (bd 730 m, 36°51'0N/27°40'4E).

knot). A total of 13 specimens ranging from 31 to 54 mm in dorsal mantle length (ML) were collected during three hauls on 23 and 24 April 1992 :

Station 1 : 1 male (ML 37 mm), 3 females (ML 38, 38, 43 mm).

Station 2 : 3 males (ML 34, 36, 54 mm), 2 females (ML 46, 54 mm).

Station 3 : 3 males (ML 31, 38, 44 mm), 1 female (ML 44 mm).

One specimen of *Octopoteuthis* sp. was caught at about 730 m of depth (Fig. 1, Station 4) using an experimental 2 m beam trawl (mesh 10 mm knot to knot) on 19 May 1991.

Close examination and photography of the specimens (preserved in 70 % ethanol) were made following standard procedures. The best preserved octopus specimens (1 female from Station 1, 1 male from Station 2) are documented by colour-photography to show the delicate skin sculpture and colours.

RESULTS

1. Species identification

1.1. Octopus cf. *aegina/kagoshimensis*

Robson (1929) pointed out the existence of several species that are closely related to *Octopus aegina*, which he considered members of a species-group. Our Mediterranean specimens clearly belong to this *Octopus aegina* complex; they were easily distinguishable from any of the Octopodinae so far known in the Mediterranean (Fig. 2A). The tentative identification as *O.* cf. *aegina/kagoshimensis* (see below, 2.) is based on the small adult size (less than 60 mm in dorsal mantle length), individual arm lengths (dorsal arms shortest), depth of interbrachial web (dorsal sector shallowest), skin sculpture (small tubercles, one conspicuous cirrus above each eye, four inconspicuous, longitudinal skin ridges arranged as corners of a lozenge on dorsal mantle surface), about 8-9 gill lamellae per outer demibranch. The (bilaterally symmetrical) rachidian teeth of the radula show a very indistinct gradation of lateral cusps turning periodically more rounded; there are no additional ectocones. The funnel organ is broadly W-shaped. The sexual duct of the male has a very peculiar terminal organ (cf. Robson 1929, Fig. 32) and contains large spermatophores, more than 30 mm in length. The female produces small eggs (ca 2 mm in chorionic capsule length).

1.2. Octopoteuthis sp *(probably O. megaptera)*

The single specimen of *Octopoteuthis* sp. caught near Bodrum was badly damaged during capture (Fig. 3); it is tentatively identified as *O. megaptera* based on the pointed, free mantle tip, the presence of two ventral mantle photophores located slightly anterior to the posterior end of the fins, and the absence of photophores at the bases of arms 3 and 4 (Nesis 1982). These characters exclude *O. sicula*, the only species of the genus so far known in the Mediterranean.

2. Skin patterns and inner anatomy of Octopus cf. *aegina/kagoshimensis*

One of the two subgroups of the *Octopus aegina* complex as defined by Robson (1929) is characterised by the absence of an ocellus on either side of the arm bases. This subgroup contains *Octopus aegina* Gray, 1849 and *O. hardwickei* Gray, 1849.

No ocellus is visible in our specimens; they do show, however, though rather faintly, the "four londitudinal ridges in crucifix arrangement on dorsal mantle" (Norman 1992) which are characteristic for the whole *O. aegina* complex.

The terminal part ("penis") of the male duct closely resembles Fig. 32 in Robson (1929 : p. 114). This figure was drawn after *O. kagoshimensis*, considered a junior synonym of *O. aegina* by Robson. The loop-shaped structure figured (Robson *loc. cit.*) is easily recognizable through the intact surface of the visceral sac when the mantle is opened ventrally (Fig. 2B). It consists of a tube bent into a clasp or U-shape. The somewhat longer limb of the U has a pore at its distal end. In the specimen figured here, part of a broken spermatophore emerged from that orifice, so it became immediately clear that the pore is the penial opening. The opposite limb of the U ends in a sac-like expansion, the base of which bears a short lateral appendix. Dissection of this complex showed that this sac and its lateral appendix hide the curved canal ascending from the deeper parts of the spermatophoric complex. The terminal organ contained an intact spermatophore (Fig. 2B-D) which occupied the lumen of the canal, forming a complete loop with its distal end (Fig. 2D, E), while the curved proximal end was inserted in the hidden part of Needham's sac. The spermatophores are unarmed (crochets absent) and measure from 30 to 60 mm in length, nearly 40 mm in the specimen shown in Fig. 2.

In the female shown in Fig. 2, each distal oviduct measures about 25 mm in length, the proximal one fourth being the oviducal gland, which measures about 4 mm in diameter (Fig. 2F). The distal end of the oviduct opens into the mantle cavity without forming a papilla above the surface of the visceral complex.

The most advanced, yolky eggs in the ovary were not yet mature, but their total length of 3 mm indicates that the mature eggs must be small (chorion capsule about 2 mm in length without the chorion stalk).

DISCUSSION

Systematics of the Octopus aegina species-group

As mentioned above, Robson (1929) figured and described the male organs of *O. kagoshimensis* Ortmann, 1888, which he considered a junior synonym of *O. aegina* Gray, 1849 : "The structure of the penis and its accessory organ is very remarkable, and like that of no other Octopod which I have seen. From Fig. 32 it will be seen that it consists of (A) the penis proper with a short rounded appendix, (B) a second penial appendix,

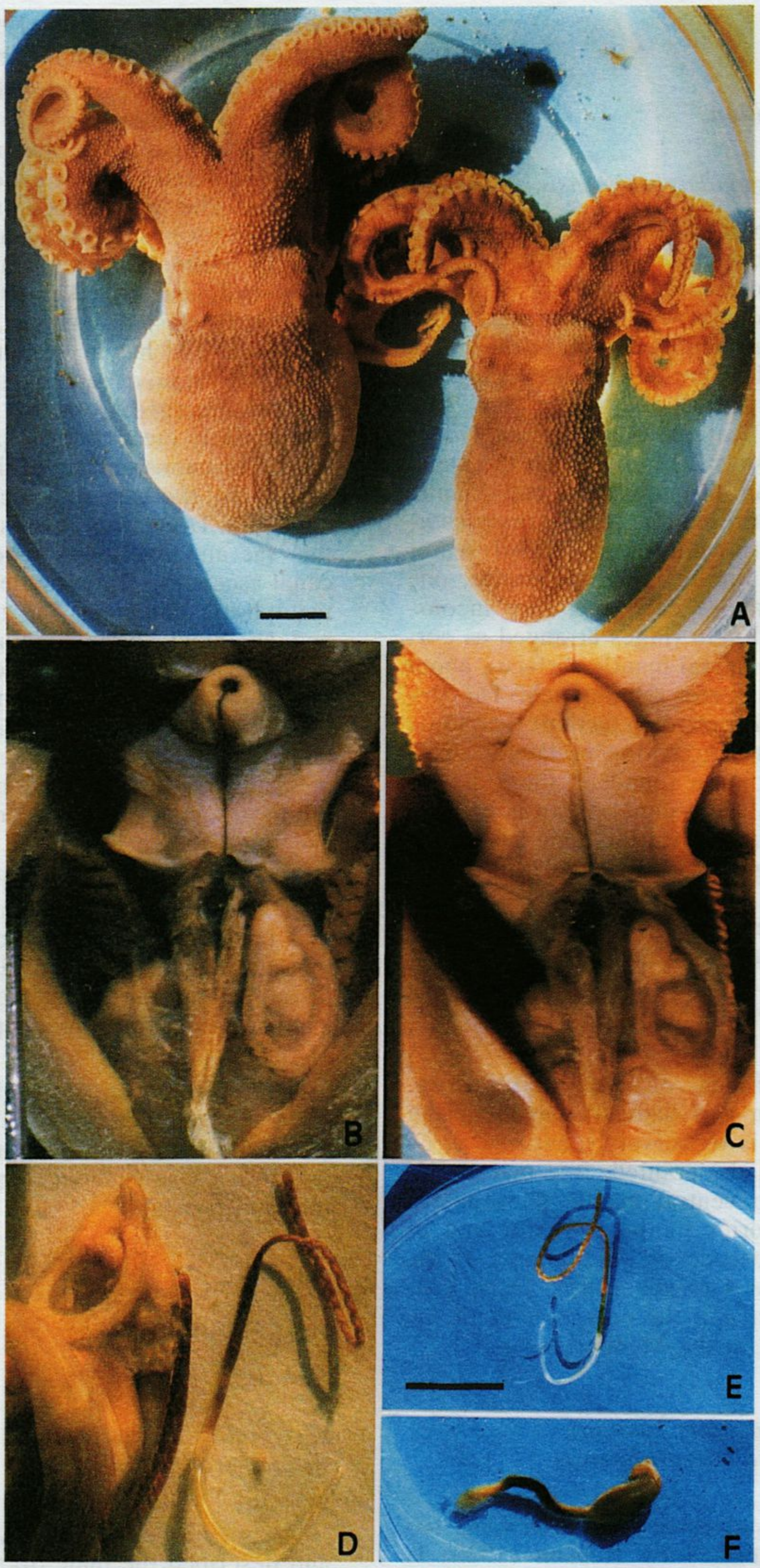

Fig. 2. – *Octopus* cf. *aegina/kagoshimensis*, preserved specimens. A, Female (left) and male (right) in dorsal view (scale bar : 10 mm). B, Funnel and visceral mass of male specimen in ventral view (muscular mantle cut open and spread laterally), note the clasp-shaped terminal organ of the sexual duct on the right side (left side in the animal). C, Similar view as in B, but distal part of terminal organ cut open to expose the end of the spermatophore enclosed in the organ. D, Same spermatophore as in C fully exposed, tilted (cf. E), placed next to the sexual duct complex dissected out. E, Same spermatophore, at lower magnification, in the orientation corresponding to that of the terminal organ in C and D (scale bar : 10 mm). F, Distal part of the left oviduct of the female, with the oviducal gland at right, at the same magnification as E.

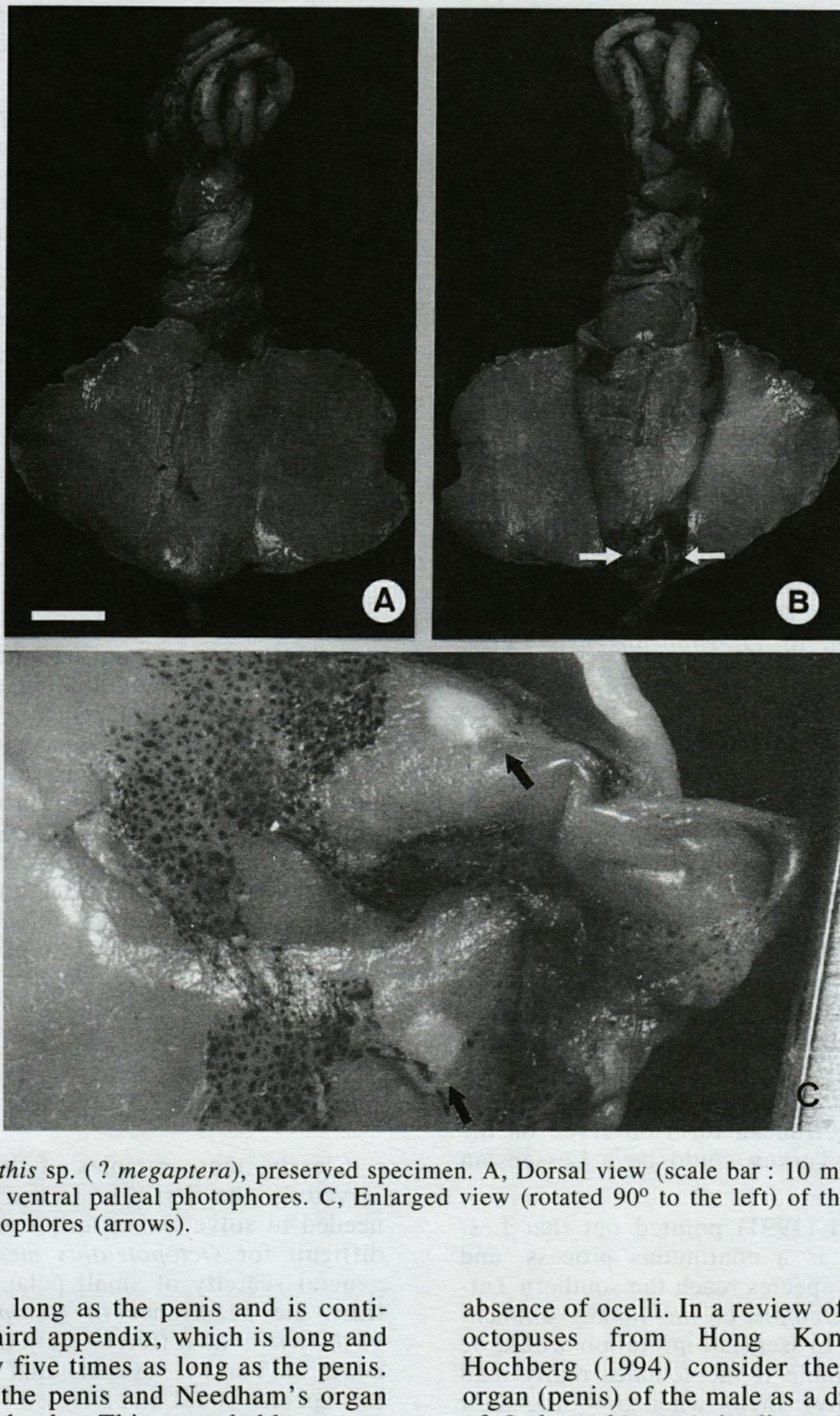

Fig. 3. – *Octopoteuthis* sp. (? *megaptera*), preserved specimen. A, Dorsal view (scale bar : 10 mm). B, Ventral view, arrows point at the ventral palleal photophores. C, Enlarged view (rotated 90° to the left) of the caudal part visible in B, with the photophores (arrows).

which is twice as long as the penis and is continued into (C) a third appendix, which is long and narrow and nearly five times as long as the penis. The duct joining the penis and Needham's organ is very long and slender. This remarkable ensemble is found in all four adult males in the type series of *kagoshimensis*. "Parts A, B, and C are not labelled in Robson's Fig. 32, but they may be recognized from the above description. As can be seen from our Fig. 2B-D, these three parts were misidentified by Robson ; he apparently interpreted the loop-shaped terminal organ as "a third appendix".

Following the general classification of Robson (1929), Norman (1992) considers again two subgroups in the *O. aegina* species-group ; his *Octopus aegina* subgroup is characterized by the absence of ocelli. In a review of the shallow-water octopuses from Hong Kong, Norman and Hochberg (1994) consider the peculiar terminal organ (penis) of the male as a distinctive character of *O. kagoshimensis* in discussing a figure (Dong 1988, Fig. 107b) that was supposed to represent *O. aegina.* In contrast to Robson (1929), they indeed consider *O. kagoshimensis* a separate species. Consequently Norman and Sweeney (1997) give the following list of non-ocellate species of the *aegina* subgroup : "*O. aegina* Gray, 1849 (including junior synonyms *O. dollfusi* Robson, 1928 and *O. hardwickei* Gray, 1849), *O. burryi* Voss, 1950, *O. kagoshimensis* Ortmann, 1888, *O. marginatus* Taki, 1964 (including junior synonym *O. striolatus* Dong, 1976) and a number of species in the Pacific and Atlantic oceans historically treated under the names *O. granulatus* Lamarck, 1798 (e.g. Sasaki 1929) and *O. rugosus* Bosc, 1792 (e.g. Robson 1929)".

Of potential interest to our discussion is the Atlantic species *O. burryi* mentioned by Norman & Sweeney (1997), since the skin sculpture and colour patterns of this species (Hanlon & Hixon, 1980) appear similar to what can be seen in our Mediterranean specimens. It is noteworthy that spawning females of *O. burryi* carry their egg strings in the arm crown (Forsythe 1984) in a way similar to what was described by Eibl-Eibesfeld & Scheer (1962) for an octopus that was identified as *O. aegina* by W. Adam of the Natural History Museum at Brussels. Incidentally, this specialist of cephalopod systematics described also *O. burryi* from the West African coast (Adam 1960, 1983). The question whether our Mediterranean specimens might be related to this species can be answered in the negative, however, since the genital system of male *O. burryi* lacks the characteristic penial loop of *O. kagoshimensis* (Voss 1951).

Toll and Voss (1998) conclude that *Octopus aegina* should be considered a nomen dubium, whereas *O. kagoshimensis* Ortmann, 1849 and *O. hardwickei* Gray, 1849 may be valid species, the former having unarmed spermatophores (crochets absent), whereas the spermatophores of *O. hardwickei* are armed (with crochets).

Lessepsian migration

Our octopus specimens clearly differ anatomically from the Atlantic *O. burryi*, whereas striking anatomical similarities with the Indo-Pacific *O. aegina/kagoshimensis* exist. The question thus is whether the Mediterranean form observed on the southern coast of Turkey could be a Lessepsian migrant.

Spanier & Galil (1991) pointed out that Lessepsian migration is a continuous process, and that many migrant species reach the southern Turkish coast. In our *Octopus* cf. *aegina/kagoshimensis*, conditions for Lessepsian migration would be particularly favourable if the females really tend to use empty bivalve shells when brooding their eggs, as described by Eibl-Eibesfeldt & Scheer (1962) for an individual from the Nicobar islands (later identified as *O. aegina* by W. Adam, as mentioned above). Empty bivalve shells remaining attached to a hull below the water line could be adopted by a female octopus when a ship heaves to in shallow water or calls at a port. Thus a passive transfer of brooding females from the Indian Ocean via the Red Sea to the Mediterranean is at least conceivable. What is particularly significant in the report of Eibl-Eibesfeldt & Scheer (1962) is that the observed female did not attach her eggs to the inside of the bivalve shell in which she lived. She carried her eggs in the arms and thus could leave her den without abandoning her eggs.

The habitation depth of *Octopus* cf. *aegina/kagoshimensis* on the southern Turkish coast (60 to 70 m of depth) raises some ecological questions if the species has really arrived from shallow waters of the Red Sea (*cf.* Adam 1973 : records from the region of Eilat !). Such questions can only be answered by new samples from areas closer to the Egyptian coast. In any event, it seems more likely that females with eggs enter the Mediterranean as Lessepsian migrants, rather than that planktonic early juveniles or advanced benthic young migrate through the Suez Canal.

In contrast to what pleads in favour of Lessepsian migration in the *Octopus* species considered here, an introduction of *Octopoteuthis megaptera* via the Suez Canal seems rather unlikely. This dominantly mesopelagic species (which ascends to epipelagic levels only during the night) would probably not survive during a passage through the Suez Canal, although floating egg masses might stand accidental displacement. The most conceivable candidates for displacement would be egg masses surviving in ballast tank water of ships entering the Mediterranean through the Suez Canal. However, it seems more likely that *O. megaptera* has so far gone unnoticed in the Mediterranean, or else that animals and/or egg masses have been carried into the Mediterranean by the surface water inflow of the straits of Gibraltar.

CONCLUSION

Clearly, more samples of the two species observed for the first time in the Mediterranean are needed to solve the open questions. This may be difficult for *Octopoteuthis megaptera* given the general scarcity of small pelagic squids. In contrast, the occurrence of *Octopus* cf. *aegina/kagoshimensis* at different stations on the southern coast of Turkey suggests that more material of this species could be collected for a detailed study of both biological and taxonomic features. With the biochemical and molecular methods now available for the study of populations, species, and phylogenetically defined groups, it should be possible to clarify the systematic relationships of this octopus species and its closest allies outside the Mediterranean.

ACKNOWLEDGEMENTS. – We are grateful to Prof. L. Laubier (Marseille) for his critical reading of an early draft of this paper. Dr. F.G. Hochberg (Santa Barbara, California) is gratefully acknowledged for his advice during the examination of the specimens and for invaluable assistance in the literature search.

REFERENCES

Adam W 1960. Les Céphalopodes de l'Institut Français d'Afrique Noire. II. *Bull Inst Franç Afr Noire* 22 : 465-511.

Adam W 1973. Cephalopoda from the Red Sea. *Contr Knowl Red Sea* 47 : 9-47.

Adam W 1983. Cephalopoda from West and South Africa. *Atlantide Rep* 13 : 151-180.

Barash A, Danin Z 1989. Marine Mollusca at Rhodes. *Isr J Zool* 35 : 1-74.

Bello G 1986. Catalogo dei Molluschi Cefalopodi Viventi nel Mediterranea. *Boll Malacologico* 22 : 197-214.

Dong Zh 1988. Fauna Sinica, Phylum Mollusca, Class Cephalopoda. Science Press, Beijing, 201 p.

Eibl-Eibesfeldt I, Scheer G 1962. Das Brutpflegeverhalten eines weiblichen *Octopus aegina* Gray. *Z Tierpsychol* 19 : 257-261.

Forsythe JW 1984. Observations on the reproductive biology of *Octopus burryi*, Voss 1950. *Amer Malac Bull* 2 : 92.

Hanlon RT, Hixon RF 1980. Body patterning and field observations of *Octopus burryi* Voss, 1950. *Bull Mar Sci* 30 : 749-755.

Mangold K, Boletzky Sv 1988. Mediterranean Cephalopod Fauna. *In* The Mollusca Wilbur KM, ed., vol. 12. Clarke MR, Trueman ER, eds. Paleontology and neontology of cephalopods. London, Academic Press : 315-330.

Naef A 1923. Die Cephalopoden (Systematik). *Fauna Flora Golf Neapel* 35 (I-1) : 1-863.

Nesis KN 1982. Cephalopods of the World. Neptune City NJ : TFH Publications, 351 p.

Norman MD 1992. Systematics and Biogeography of the Shallow-Water Octopuses (Cephalopoda : Octopodinae) of the Great Barrier Reef, Australia. Ph D Dissertation, Univ Melbourne, 281 p.

Norman MD, Hochberg FG 1994. Shallow-water octopuses (Cephalopoda : Octopodidae) from Hong Kong's territorial waters. *In* The Malacofauna of Hong Kong and Southern China III (B Morton, ed.). Proc 3rd Intern Workshop on the Malacofauna of Hong Kong and Southern China, Hong Kong (13 April-1 May 1992) : 141-160.

Norman MD, Sweeney MJ 1997. The Shallow-water Octopuses (Cephalopoda : Octopodidae) of the Philippines. *Invertebr Taxonomy* 11 : 89-140.

Orsi Relini L, Massi D 1991. The Butterfly Squid *Stoloteuthis leucoptera* in the Mediterranean. *J mar biol Ass UK* 71 : 47-51.

Robson GC 1929. A Monograph of the Recent Cephalopoda. Part I, Octopodinae. London : The British Museum Publications, 236 p.

Ruby G, Knudsen J 1972. Cephalopoda from the Eastern Mediterranean. *Isr J Zool* 21 : 83-97.

Spanier E, Galil BS 1991. Lessepsian migration : a continuous biogeographical process. *Endeavour* NS 15 : 592-596.

Toll RB, Voss GL 1998. The Systematic and Nomenclatural Status of the Octopodinae Described from the West Pacific Region. *In* Systematics and Biogeography of Cephalopods (Voss NA, Vecchione M, Toll RB & Sweeney MJ, eds). *Smiths Contr Zool* 586 : 489-520.

Voss GL 1951. Further description of *Octopus burryi* Voss with a note on its distribution. *Bull Mar Sci Gulf Caribbean* 1 : 231-240.

Würtz M, Matricardi G, Repetto N 1995. Sepiolidae (Mollusca, Cephalopoda) from the lower Tyrrhenian Sea, Central Mediterranean. *Bull Inst océanogr Monaco* n° sp. 16 : 35-39.

Reçu le 4 février 1998 ; Received February 4, 1998
Accepté le 6 juillet 1998 ; Accepted July 6, 1998