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Report on the first meeting of the International Working Group on Majid Crab Biology (November 10-12 1993, Paris France).

by

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Summary:

The international Workshop on Majid Crab Biology was set up as an informal forum for all scientists of any country and organization interested in sharing results and cooperative research on the physiology, life cycles, population biology, and behaviour of majid crabs. New members are introduced upon nomination from two existing members. Meetings are scheduled to take place every two years.

The first meeting took place at Université Pierre et Marie Curie and at Muséum National d'Histoire Naturelle, Paris, France. It was attended by scientists from Brazil, Canada, France, Germany, New Zealand, Russia, Spain, U.K., and USA.

Communications dealt with life history, reproductive behaviour, morphometry, evolution, cryptic behaviour, endocrinology, and histology of endocrine glands. The workshop does not deal with topics directly related to fisheries management. However, the knowledge it brings on the basic biology of majid crab, from an enlarged international forum may provide a useful basis for setting up fisheries regulations in the context of ICES.

Introduction:

Several important commercial species pertain to the majid crab family: *Maja squinado*, *Chionoecetes spp.*, and are harvested both in the Atlantic and the Pacific. The majid crab family has a unique biological characteristic among Decapod crustaceans, it is believed by most scientists that both males and females reach a terminal anecdysis, that some compare with the imaginal molt of insects. The presence of this characteristic has and is at times still disputed. The significance of a terminal anecdysis for the reproduction strategy of the species is not fully understood in an evolutionary context. The endocrine regulation of the appearance of the terminal molt is not known. The environmental determinism of the terminal molt is not known. Peculiar behavioral characteristics such as a morphometric differentiation of the claw at the onset of the terminal molt appears to be characteristic of the family. A typical grasping behaviour of the female by the male has been described for several majid species and may be common to all, its significance for reproductive success is interpreted differently by authors working on different species. The populations of certain species of majid crab appear to segregate by sex and maturity categories, different spatial structures suggesting social interactions have been described.

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Themes considered during the sessions:

Phasing of seasonal events in the life history of majid crabs with environmental factors
Hormonal control of moulting and mating
Mating and moulting behaviour
Seasonal migrations and timing of life history events
The terminal moult, its determinism by environmental and hormonal factors
Detection of hormone production by the endocrine glands regulating moulting
Spatial dispersion of majid crabs: some evidence for a social behaviour
Pheromones and other means of communication during mating and moulting
The morphology and evolution in majid crabs in relation to mating and moulting

Presentations:

The following abstracts are based on the summaries provided by the authors and/or on notes taken by the chairpersons when the presentations provided additional information. Not all of the abstracts have been revised by the authors, please refer to the authors for additional information, and please ask for their permission before quoting their results.

Systematics and evolution

Danièle Guinot: "The classification of Majidae in the context of recent advances in the knowledge of systematics and evolutionary trends in Brachyuran Decapods".

A revised classification of decapods (D. Guinot, 1979, Mém. Mus nat. Hist. nat., 112, 1-354) regroups the families according to the position of the male and female sexual openings.

The Podotremata carry the sexual openings of the females and males on the coxal segment of pereiopods 3 and 5 respectively. The Dromiidae, Dynomenidae, Homoloidae, and Raninidae share this characteristic. The two claws are of equal size.

In the Heterotremata the female carry the sexual openings ventrally on the sternite 6 (which corresponds to pereiopod 3), in the form of paired sternal vulva . The male bare the sexual openings on the coxa of pereiopods 5. The Calappidae, Dorippidae, Leucosidae, **Majidae**, Parthenopidae, Portunidae, Xanthidae among others share this characteristic.

In the Thoracotremata both female and the male sexual openings are sternal. The Hymenosomidae, Gecarcinidae, Grapsidae, Ocypodidae and Pinnotheridae among others share this characteristic.

Marcos Tavares: "Thelycum and spermatheca in decapod crustaceans" (Summary presently published in 1993 C.R. Acad. Sci. Paris, 316, 3, 133-138.)

The thelycum and spermatheca are morphologically very distinct structures but have the same functions: the storage of spermatophores. The thelycum is a structure derived from sternal modifications always of a single segment. It can be on the sixth, seventh or eighth thoracic sternite and can be either an invagination or an evagination. The spermatheca is a structure derived always from two adjacent segments, that is, a split between the plates of the intersegmental phragma. One plate of this phragma is derived from sternite 8 and the other from sternite 7. The spermatheca always involves these two segments (except, as far as we know, in the penaeioid genera *Gennadas* and *Bentheogennema* in which it is derived from 7/6. The thelycum and spermatheca are not connected to the ovary.

In the heterotreme and thoracotreme crabs the spermatophores are deposited in two openings (vulva) in the mid-length of sternite 6. The vulva are derived always from sternite 6 and are

connected to the ovary by the oviduct which is not the case in a thelycum. The part of the oviduct connected to the vulva is exodermic and the part connecting to the ovary is mesodermic. Although the spermatophores can be stored in the oviduct this system allows for direct fertilization. A specific place for storage of spermatophores, independent of that storing the eggs, does not exist.

Pierre Noël: "Recent research on the phylogeny of decapods by immunology".

Research is presently conducted on the relationships between species of decapods by using specific haemocyanin antisera. *Medorippe* and *Maja* appear to be closely related and have diverged early from other groups such as *Carcinus* and *Potamon*, or *Eriocheir*. Its is not known yet whether immunology will allow to discriminate subpopulations of a same species.

Volker Neumann. "Morphological/morphometrical differentiation between life stages of different European *Maja* species in the context of systematics. Remarks on morphological differentiation and evolution in majid crabs".

Different *Maja* species (*M. squinado, M. crispata*) from the Mediterranean can be distinguished by allometric relationships. However the species go through successive stages of morphometric development characterized by different allometric relationships, It is sometimes difficult to decide whether individuals with a different morphometry pertain to different species, or to successive stages of development.

Endocrinology and histology

Hans Laufer, Jonna S.B. Ahl, and Amir Sagi. "The relation of Methyl Farnesoate to Reproduction in Majid Crabs".

Methyl farnesoate (MF) is the unepoxidated form of the insect juvenile hormone (JH III) which in insects control reproduction and reproductive behaviour. MF seems to perform the same functions in the majid crab, *Libinia emarginata*. MF is synthesized in the mandibular organs (MOs) and is present in the blood of both males and females.

MF is most abundantly produced my MOs in females during vitellogenesis. In males high MF production by the MOs and high concentrations in the blood are associated with large reproductive systems and active mating behaviour. High MF concentrations occur in animals of specific morphotypes: the abraded forms. These are males in which the epicuticule of the carapace has been worn away with the passage of time. Unabraded crabs appear to be in a state of reproductive inactivity or diapause. The relationship of MF to reproduction is thought to be causal since implants of active MOs into juvenile females result in a stimulation of gonad development.

We have tested small numbers of several majid crabs, including *Chionoecetes opilio*, *Loxorhynchus grandis* and *Libinia dubia*. All have mandibular organs which produce MF consistent with the findings in *Libinia emarginata*. Thus, MF may play an important role in majid crab reproduction and reproductive behaviour.

Auguste Le Roux: "Recent research on the anatomy and histology of the mandibular organ of Majid crab. Histological modifications of the mandibular organ during moult stages in *Chionoecetes opilio*".

Samples of the mandibular organs of the specimens prepared for electron microscopy by G. Conan and M. Hubert were processed by light microscopy. It appears that the mandibular organ displays different histological structures at different times of the intermoult cycle. Further samples will be processed to identify whether histological preparations of the mandibular organ can detect the functional activity of the organ, and its possible relationship with the preparation for the moult to terminal anecdysis.

Gérard Conan and Michelle Hubert: "Moulting, terminal anecdysis and the ultrastructure of the Y organ of *Chionoecetes opilio*".

The Y organ of decapods is believed to regulate moulting by producing the molt hormone crustecdysone. Therefore, the Y organ should regress after the molt to terminal anecdysis. Male *C. opilio* having reached terminal anecdysis are easily identified by morphometry. The allometric relationship between the carapace size and the size of the claw changes abruptly when the individuals achieve the terminal molt and become morphometrically mature (Conan and Comeau 1986).

In order to verify whether the Y organ regresses after the molt of morphometric differentiation, three samples of Y organ were prepared for transmission electron microscopy. The first sample was taken from a morphometrically differentiated male in anecdysis, another one from a juvenile male also in anecdysis, but having moulted recently, and the last from a juvenile male having skipped the spring moult.

The Y organ of the morphometrically differentiated male clearly displayed signs of regression such as myelinic degenerative structures. The juvenile recently moulted male had a clearly functional Y organ. The juvenile skip moulter had a functional but apparently less active organ.

Research is being pursued to test a small sample of animals, it appears that histology of the Y organ may provide a reliable tool for identifying whether a crab has achieved the terminal anecdysis without having to rely exclusively on morphometry.

Growth

Richard Hartnoll. "The moult increment in majid crabs" (summary sent to the meeting)

It is accepted for most crabs that the moult increment follows a fairly standardised pattern. As the crab increases in size the increment, in percentage terms, becomes progressively smaller, After sexual maturity the decline in the increment becomes even more marked, and the increment may become negligible. These patterns have obvious implications in relation to asymptotic growth.

In spider crabs, however, and in some other crabs with determinate moulting patterns, there is evidence that moult increment does not decline (Hartnoll 1983, Strategies of crustacean growth. Mem. Aust. Mus. 18, 121-131). Studies to follow up this idea have been rather limited.

Recently we (Hartnoll & Bryant, in prep.) have looked at moult increment critically in *Hyas coarctatus* and *Inachus dorsettensis*. The moults between juvenile instars and the puberty moult, were analyzed separately. There was no tendency for percentage increment to decrease with size (except a slight trend in male *Inachus dorsettensis*). In *Hyas coarctatus* the increment at puberty moult was, in both sexes, smaller than at juvenile moults for the same body size. In contrast, it was larger in *Inachus dorsettensis*.

The implications in relation to the patterns of growth and the timing of gonad maturation are investigated.

Factors affecting mortality

Guénaëlle Wilhelm: "Recent research on the presence of Haematodinium in Maja squinado".

Haematodinium infestations are quite common in several European crab species. Up to 60 % of *Necora puber* may be infested by *Haematodinium*. *Haematodinium* is also common in *Cancer pagurus*. Research is presently on going for identification of *Haematodinium* in *Maja squinado*. It is not clearly understood whether the same species of *Haematodinium* infects several species of crab, electrophoresis tends to show different profiles, but common characters are also found.

Boris G. Ivanov. "Limb loss in crabs (Crustacea Decapoda: Brachyura Majidae and Anomura Lithodidae): purposes and methods of its study exemplified by crabs of the Bering Sea".

There is a high incidence of crabs having lost part of their limbs in the commercial catch of majid species (*Chionoecetes opilio, C. bairdi, C. angulatus*, and *C. tanneri*) and of lithodid species (*Paralithodes platypus, Lithodes aequispina, L. couesi*) in the western Bering sea. The proportion of crabs with missing legs is much higher (as much as 15%) in majids than in lithodids (5%). The losses tend to by symmetric in majids and asymmetric in lithodids.

The differences between the two types of crab may result from the presence of a terminal anecdysis in majid crabs. Majids are believed to be unable to regenerate once they reach terminal anecdysis.

Life history

Colin L. McLay: "Cryptic behaviour in New Zealand Majid crab"

Many Majid crab species (Exception being made for the Genus *Chionoecetes*) have a cryptic behaviour, i.e. tend to camouflage by covering their carapace with pieces of seaweed or debris. Many species who camouflage bear hooked setae which hold the material in place. The camouflage behaviour can be quite elaborate in the preparation of the artifacts used for covering the carapace frequently repeated. Another interpretation is that the camouflage is indeed a food reserve. Camouflaging is a trait which is also quite common among Podotremata.

Jocelyne Martin: "Period of eclosion of the larvae of the spider crab *Maja squinado* Herbst in the British Channel and spring water temperature".

Zooplankton was sampled monthly and at times bi monthly from 1977 to 1979 and from 1983 and 1992. Water temperatures were measured simultaneously. Great year to year variability was observed in the hatching period. The period over which hatching is initiated may range from early June to late July. Maximum hatching is usually observed sometime between early July and early September. It is believed that hatching occurs early when high water temperatures are reached in the spring.

Eduardo González-Gurriarán. "The use of ultrasonic telemetry to monitor movements of the spider crab *Maja squinado* (Decapoda: Majidae) in the Galician waters (NW Spain)".

Conventional tag data have demonstrated seasonal migrations of *Maja squinado* in several geographic areas. However the conventional approach does not provide in depth information on speed, orientation, diel and seasonal activity rhythms affecting these migrations.

Ultrasonic telemetry allow to monitor small and large scale movements of *M. squinado* in Galicia. Juveniles move only over short distances at speeds of no more than 50m per day and with no specific privileged orientation. In summer the juveniles are located in kelp beds at shallow 3 to 10 m depths. Once they have undergone the pubertal moult in late summer, the adults remain in the same area as the juveniles and have similar patterns of movement. Later in autumn, the adults move preferentially and at greater speeds towards deeper rocky and sandy areas. The females reach gonadal maturity and initiate their breeding cycles in these areas.

The gonads of the females always develop after the molt of morphometric differentiation. Recently moulted soft shell females have never been found with spermatheques full, mating occurs during the terminal anecdysis long after the molt. Three to five broods are produced from April to

September. In September 80% of the females are berried, in October they stop producing eggs and by December all the eggs have hatched. Females are frequently found in the field with few or unfertilized eggs.

Daniel Latrouite: "Biology and harvesting of the spider crab *Maja squinado*".

M. squinado is distributed over some 40 degrees of latitude in the Mediterranean sea and the Eastern Atlantic (Europe and Africa). The annual catch does not exceed 10 000 tons, it proceeds mainly from the western British Channel. The fishing fleet is mainly French, and to a lesser degree from the Channel Islands. Five hundred boats fish 2 million traps in Brittany. The crabs are harvested by tangle nets (5 km per crew member). The fishery is closed in September and October.

In France, the assessments are made by systematic sampling. Each sample is a using 2 mile dredge tow.

M. squinado reach maturity in 2 to 3 years and reproduce twice a year in Brittany. The locomotory activity increases with temperature. Terminal anecdysis has been an accepted fact ever since the work of Tessier in the 1930's. Old animals are rare, only the very small are left. Over the past 25 years larger crabs have been selectively removed by the fishery. The females are harvested as well as the males. At times, females are found with non fertilized eggs. Recruitment varies by a factor of one to five.

A Ph. D. thesis was recently produced by D. Le Foll: " Biologie et exploitation de l'araignée de mer *Maja squinado* en Manche Ouest".

Rudolf Diesel: "The Mating Strategy of the Symbiotic Spider Crab, *Inachus phalangium*".

Inachus phallangium is a small majid crab living on the sea anemonae Anemonia sulcata in the Mediterranean. There appears to be one generation per year. One female will produce up to 8 broods. The whole life cycle takes about 2 years, after which a terminal anecdysis is reached, the animals die a few months after the terminal anecdysis. The females are only slightly smaller than the males.

The male holds the female face to face by the antenna in the preparation for mating. Males mate with females in any state, with or without eggs, but more likely if the female is ready to spawn. There is strong competition between males. The female is guarded by the male after mating if she is ready to spawn. The larger males are usually the last to mate prior to spawning, their spermatophores are deposited towards the opening of the spermatheque, and the seminal fluid flushes previous spermatophore packages upwards, and hardens them. The sperm from the last male is used for fecundating several broods afterwards.

It is believed that part of the internal spermatheque originates from ectoderm of a formerly external thelycum in previous stages of evolution.

Guy Charmantier and Mireille Charmantier-Daures: " Salinity tolerance and osmoregulation in zoeae and juveniles of the snow crab *Chionoecetes opilio*".

Osmoregulation and salinity tolerance were studied in zoeae 1 and instar IX juveniles. In zoeae 1, the lower and upper lethal salinities for 50% of the animals (LS 5) at 14 °C were about 10 per mil and 42 per mil at 24h, 41 per mil at 48h, 25 per mil and 38 per mil at 96 h. In juveniles, the approximate 48h Ls 50 at 6°C were 13.5 per mil and 46 per mil.

Isosmotic and isoionic regulation in post-metamorphic stages are known from Maja, Hyas and possibly *Libinia*. These characteristics are presumably an attribute of the majid family.

However, both zoeae and juveniles of *Chionoecetes opilio* were able to withstand ample but short variations of salinity. On the long term, zoeae were hyper-osmoconformers, while juveniles were osmoconformers and isoionic to the external medium except for Mg^{++} which was hyporegulated. The short term euryhalinity may be related to the characteristics of the distribution of the zoeae and juveniles in the in the field.

Gérard Conan: "Life History of *Chionoecetes Opilio*, an adaptation to a highly seasonal environment".

Ten years of observations on a small population of snow crab isolated at the benthic stages inside the sill of a deep Newfoundland fjord have produced determinant information on the life history of this species.

Snow crab live in deep water pocket in the fjord. The water remains from year to year between -1 to +1 °C. A thermocline forms in the spring and progressively moves down to 60 m in the Fall. Above the thermocline the water temperature may rise to 15 °. The crabs move down below the thermocline except for some berried females who speed up the development of their eggs at 3 to 5°C. Female spawn immediately after mating in late May to early June, the eggs are carried under the abdomen for up to two years, although some females may achieve a one year development by remaining in warmer water.

The signal for egg hatching is given by a rain of organic carbone produced from the spring phytoplankton bloom. Snow crab can exactly match the spring bloom and avoid match mismatch fluctuations in recruitment which would result from incorrect timing of the larvae release.

The megalopes are recruited to the grounds in late August. It takes about 5 years for the males and females to reach a functional maturity stage. However, not all individuals in a cohort reach simultaneously maturity. Although the gonads of the males start de produce some spermatophores in the third year, actual functional maturity is reached only after a specific differentiation of the

claw . This secondary sexual character develops at the onset of the last molt in the life cycle of the animal. This specific molt can be reached anywhere in the 5th to 10th year of life of the males or the females. The animals who reach this terminal anecdysis do not appear to survive more than 5 years. Soon the carapace becomes abraded, limbs which are lost cannot be regenerated, microorganisms slowly destroy the carapace.

Females will reproduce twice, at the most three times in their life spawn. They are much smaller than the males but take about as long to grow. Each spawning takes place immediately after mating. Females do have a "spermatheca" which is actually a differentiation of the oviduct canal and not a true spermatheca (See Tavares). The spermatophores in the "spermatheca" are said to remain functional from one year to the next, however it appears that in nature this safeguard is seldom if ever used.

Males hold the females in precopulatory embrace for several days or weeks until the eggs of the female hatch. One claw of the male is used to hold the pereiopods of the female in a facing position, the other claw is used to fence away the other males. This behaviour has also been described of other species of *Chionoecetes* from the Pacific ocean. However it appears to be Genus specific, the related Hyas collected in the same area have a different embrace, the male holds face to face the claws of the female.

Mating takes place immediately after egg hatching, the female is turned up side down under the male, both individuals now facing the same direction. Actual mating is much shorter than the precopulatory embrace. Mating is promptly followed by the extrusion by the female of a new clutch of eggs. Mature females are almost never found without a clutch of eggs, except when they become senile.

After the 2nd year and until they reach the terminal molt males and females usually molt once per year in the spring. However some individuals appear to sometimes molt in early winter and skip the spring molt. It is not known what triggers this " skip moulting" behaviour.

Social interactions such as delay of the molt of the juveniles by the morphometrically mature, attraction of the males by the females by other means than the classic pheromone derived from the molt hormone are suspected but not demonstrated. Podding behaviour of the females prior to mating has not been observed. Males, females and young immature crab tend to segregate in different patches. A cannibalistic behaviour of the morphometrically mature, terminal anecdysis males on the recently moulted juveniles is observed in aquarium, but has not been documented in nature.

Considerable fluctuations in cohort strength have been observed as early as the first benthic stages, but not in the planktonic stages. The metamorphosis to the benthic stages (megalope) may be the determinant step in the success of recruitment. Over the period of study a 5 year interval has been observed between major recruitment successes, however, it is too early to conclude about a periodicity pattern.

General Discussion

Individual presentations lead to general theme discussions :

The determinism of the terminal molt is not known. The factors that contribute to induce an individual to achieve the terminal molt rather than growing to larger sizes as a juvenile are not known. As shown in Chionoecetes opilio, the individuals from a same cohort will reach the terminal molt over a long range of several years. Once the terminal molt is reached, reproduction is possible, but death will happen relatively shortly due to the impossibility to regenerate or rejuvenate an old carapace. It is not known whether each individual is genetically preprogrammed to achieve its terminal molt at a given age, whether environmental and intra-population regulatory factors intervene.

The concept of terminal molt is now accepted by most authors for most species of majid crab studied. The significance of the terminal molt as an evolutionary trait is not well known. It may be an archaic trait, or a modern trait which was discovered several times, or both. The presence of a terminal molt appears to be general within the family Majidae. Among other families of decapods, only certain species (*Corystes spp.*) have been described to have a terminal molt . The terminal molt, as it is described for certain Thoracotremata may have a totally different biological significance, and may be a recent discovery. Conversely there is scarce unpublished information suggesting that at least certain archaic Podotremata may reach a terminal molt.

Life histories within a same species may vary with latitude as demonstrated by the observations on *Maja squinado*. Particularly, the number of reproductions per year may vary.

A common reproductive behaviour may have evolved into different strategies in different species. The practice of holding the females for extensive periods seems to be a common trait in Majidae, the body part held in the claw is a characteristic of each genus or may be species: pereiopods (*Chionoecetes*), claw (*Hyas*), antenna (*Inachus*). This holding behaviour may justify the differentiation of the claw at onset of morphometric maturity, however it seems to have disappeared in male *Libinia* who were reported to hold the female by using the pereiopods. *Chionoecetes* are reported to hold the female in precopulatory embrace, possibly waiting for the eggs to receive the signal to hatch from the phytoplankton bloom, so that the male may be the only one to mate immediately after the hatching and precisely before the ensuing new spawning. *Inachus phalangium* is reported to hold the female so that the male be the last to mate and therefore to successfully fecundate the ova shortly before spawning.

Recruitment success, is highly variable from year to year in *Chionoecetes* and in *Maja* despite regulatory mechanisms such as sperm storage by the females from one spawning to the next. The main factors affecting recruitment have only recently been methodically investigated. The population structure itself may generate long term oscillations in abundance by alternating of dominating morphometrically terminal anecdysis animals and juvenile animals. In *Chionoecetes opilio* the success of the planktonic stages does not appear to generate major fluctuations in recruitment through match/mismatch with planktonic blooms.

The discrepancy between the activation of reproductive behaviour in *Libinia* vs *Chionoecetes* and *Maja* may be only apparent. Abraded males correspond to second year after terminal molt morphometrically mature males in *Chionoecetes opilio*. *C. opilio* who have recently reached terminal anecdysis have few spermatophores in their *vasa deferentia*, and require one year of tissue and gonad production before they become functional. During field observations, juvenile skip moulter *C. opilio* were not reported to mate. It would be worth checking whether The abraded males of *Libinia* are not in fact animals in terminal anecdysis irrespective of their size. A three to four fold range of sizes is not uncommon for individuals from a same cohort having reached terminal anecdysis over a wide range of successive moults.

Conversely an interesting working hypothesis would be that the presence/absence of Methyl farnesoate (MF) produced by the mandibular organ may regulate the onset of the terminal anecdysis. The production of MF could be abundant in juveniles, reduced towards the terminal molt to morphometric maturity, and abundant again during reproduction. This hypothesis may be tested by a coordinated effort for jointly processing samples as undertaken by G. Conan, M. Hubert, H. Laufer and A. Leroux.

There are practical applications to the basic biology studies undertaken. An in depth knowledge of the life history of commercial majid crabs is required for developing efficient and practical methods of stock enhancement and enhancement of the commercial value of the catch:

-The recent advances in the analysis of recruitment fluctuations and of the factors affecting recruitment both by analysis of laboratory experimental data and by field observations may allow to predict recruitment strength many years ahead of time. A prediction of recruitment strength allows to adjust quotas and market to the annual production.

-The identification of the early benthic nursery grounds which appear to differ from the grounds occupied by commercially harvested stages in Maja and Chionoecetes may allow to specifically protect and enhance early recruitment by restricting trawling and dredging on these grounds.

-The identification of the physiological and environmental factors determining the onset of the terminal anecdysis may help to identify what portion of an assessed stock will molt to morphometric maturity over the next moulting season and subsequently reach commercial quality. Conversely, the identification of the individuals who will reach the terminal anecdysis at sizes inferior to a commercial minimal size will allow to evaluate the economic potential of a recruiting cohort. Identifying whether the determinism is partly or entirely genetic may avoid long term drifts in commercial quality of the stock.

-Identification of factors affecting the survival of the larvae (tolerance to salinity variations), of the benthic stages (*Haematodinium*), of the animals in terminal anecdysis (loss of limbs, lack of regeneration, short life expectancy) will allow to predict recruitment fluctuations and to adjust the quotas annually. For instance it may not be profitable to set low quotas on a strong recruitment of terminal anecdysis males who have stopped growing and will only lose limbs, gain heavy fouling of their carapace and massively die after having completed reproduction over a few nest years.

New memberships

Applications for membership to the International Workshop on Majid Crabs are welcome. New members should be nominated by two standing members to the chairpersons of the 1993 meeting.

Next venue

Participants felt that the next meetings of the International workshop on Majid Crabs should be arranged to take place as satellites of major international Crustacean conferences in order to maximize access and reduce travel costs for the participants. The organizers of several conferences scheduled in 1995 are presently being approached for endorsing the next meeting of the International Workshop on Majid crabs.

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