UMBERTO NICOSIA

Dipartimento di Scienze della Terra, Università "La Sapienza" - Roma

AMMONITES/EPIZOANS RELATIONSHIPS IN THE KIMMERIDGIAN OF THE CENTRAL APENNINES

Ammonites and epizoans, coming from an outcrop of the Central Apennines of Kimmeridgian age, are statistically studied. The resulting data (showed by graphics) share differences in frequency and distribution between a group formed by Phylloceratids and Lytoceratids and another, assembling Ammonitids. Such differences are related to different way of life of the ammonites also if the epizoans activity results to happen in a post-mortem stage of the ammonites. Further data on the paleoenvironmental condictions of the region are given by the local presence of widespread life on the sea bottom.

Ammonite shells with traces of epizoans or grazers are quite frequent in the Upper Jurassic cephalopod limestone of the Umbrian-Marchean region.

Ammonites, coming from a single outcrop of the Central Apennines, are here studied statistically searching for epizoans, borers and fossil traces on their shells.

More than 350 ammonites and many shell fragments were collected for stratigraphical and taxonomical purposes; the outcrop, well known in the literature, is that of M. Lacerone and the ammonites come from Kimmeridgian layers that there are outcroping. We send back to previous works for both geological and paleontological data (FARINACCI, 1967; FARINACCI *et alii,* 1981; CECCA & SANTANTONIO, 1982; CECCA *et alii,* 1985).

All the studied ammonites are stored into the paleontological Museum of the Dipartimento di Scienze della Terra of the Università "La Sapienza" di Roma, collection number NS 3.

We recognized basal disks of crinoids, sedentarid worm tubes and grazing traces. Their distribution shows noteworthy differences that may be of different origin. In our hypothesis such differences could depend either by epizoans etho-ecology or by different kinds of shells, or by different way of life of the ammonites.

Taphonomy

Most of the ammonites were found parallel to the bedding plane, aside from some "nest" in which their distribution is chaotic. All the shells are almost always completely recristallized but they often show the ghost of their original structure. The shells, coming from the examined beds, are well preserved on the lower side and badly or not at all on the upper side. The latter is frequently used or stylolithized and time to time covered by stromatolitic domes. For this reason we can examine only one side of the whole material. This fact does not damage these studies because there are no doubts that most of the epizoans and traces encrust or live on rocky bottoms or on the upper side of the shells. Therefore many shells have been reworked after the action of epifaunal or grazing organisms.

This fact might be of some importance in epizoans and fossil traces statistical evaluation so, in order to avoid errors, the most important data were obtained by comparison among the percentages of various kinds of traces rather than their absolute number.

Epizoans and fossil traces

We could recognize on ammonite shells two types of action of organisms: encrustation (crinoid basal disks and tubes of sedentarid worms) and grazing traces (Fl. 1). These last, attributes to *Gnatichnus pentax* BROMLEY, are star-shaped traces of regular echinoids which grazed algal film on the shell (or rock) surfaces or preied clionid sponges or borer polychaetes (BROMLEY, 1975; SMITH, 1981). They are, up today, known only from Triassic (FURSICH & WENDT, 1977), Cretaceous (BROMLEY, 1975; VERMEIJ, 1977) and Tertiary sediments and this seems to be the first Jurassic point out.

Worm tubes and grazing traces are frequently found into the living chamber of the ammonites (Pl. 1; figs. 2, 6) and shell worls never overlaping tubes as recorded in LANGE (1932), SCHINDEWOLF (1950) and MERKT (1966).

The symbiosis of ammonites and crinoids is suggested by KUSS (1963) for *Cyrtocrinus* JAEKEL, 1891 (suborder Cyrtocrinina SIEVERTS-DORECK, 1952) with questionable evidences and, only a little more creditably by SIEVERTS (1932) for *Cotylederma lineati* QUENSTEDT, 1852 (suborder Holopodina ARENDT, 1974). If it might be acceptable for stemless Holopodina it is not for stemmed forms (BREIMER, 1978; BREIMER & WERSTER, 1975).

Grazing traces are related by FURSICH & WENDT (1977) to forms scraping off algal cover on bivalve

Work supported by Ministero Pubblica Istruzione (40%); "Piattaforme, margini e rapporti con le facies pelagiche". National Project, Rome Research Unit.

shells but is the first time that they are recognized on Ammonite shells, with the exception of the our same material mentioned in SANTANTONIO (1985).

On this basis we are able to state that all the traces were laid down, and organisms (perhaps aside worm tubes) fixed themselves, after the death of Ammonites and almost surely after the decay of their soft bodies. Moreover, due to the presence of grazers, we can consider all the traces laid down on the shells when they were on the sea bottom as skeletal remains after deposition or after reexumation.

We have analyzed our specimens in order to recognize differences in the behaviour of the various organisms. In our hypothesis, and according to the literature, differences in frequency and distribution of the traces or organisms could be considered related either to etho-ecological differences among different ammonites and epizoans or to minero-structural differences in shell kind. The literature in these fields is rich: e.g. GAETANI & FANTINI SESTINI (1978) hypothesize differences in ammonite shell mineralogy; SCOTT (1940); ZIEGLER (1967), KABAMBA & TINTANT (1983), LOMINANDSE (1983), MARCHAND (1984) and many others, on the basis of shell morphology and on the topographical and geographical distribution of different families and genera, show differences among the environments colonized by the ammonites and their shape, ornamentation and enrolement. GYGI (1986) shows relationships existing between shell shape and depth; TANABE (1979) correlates ornamentation and depth. On the basis of the kind of siphuncle, WARD (1986) recognizes differences in environment and points out differences among Phylloceratids/Lytoceratids and Ammonitids.

Analysis of the material

We examined relationships between ammonites and epizoans for what concerns dimensions, ornamentation (through higher Systematic levels) and shape of the ammonites and frequency or emplacement places of the epizoans. Data are exposed only by graphics to lighten the work.

— The dimensional distribution of the entire amount of the shells and the distribution of the ones with the traces, have been examined (Fig. 1). The comparison shows that the dimensions are not a discriminant character. This is easy to explain since the settling takes place in a post-mortem and pre-burial stage or after reexumation.

Then the ammonites have been divided in three groups, corresponding to the suborders Ammonitina, Phylloceratina and Lytoceratina; epizoans and traces percentages and topography on them are shown in figs. 2-3. The distribution of epizoans and fossil traces shows a greater presence on the ammonites of the suborder Ammonitina. The number of the traces on shells related to the other two suborders, is only a small percentage. Moreover it's clear that there is a little number of grazing traces on ammonites of the suborder Phylloceratina, while they are completely missing on Lytoceratids. The superimposion of grazing traces and crinoid basal disks or worms is

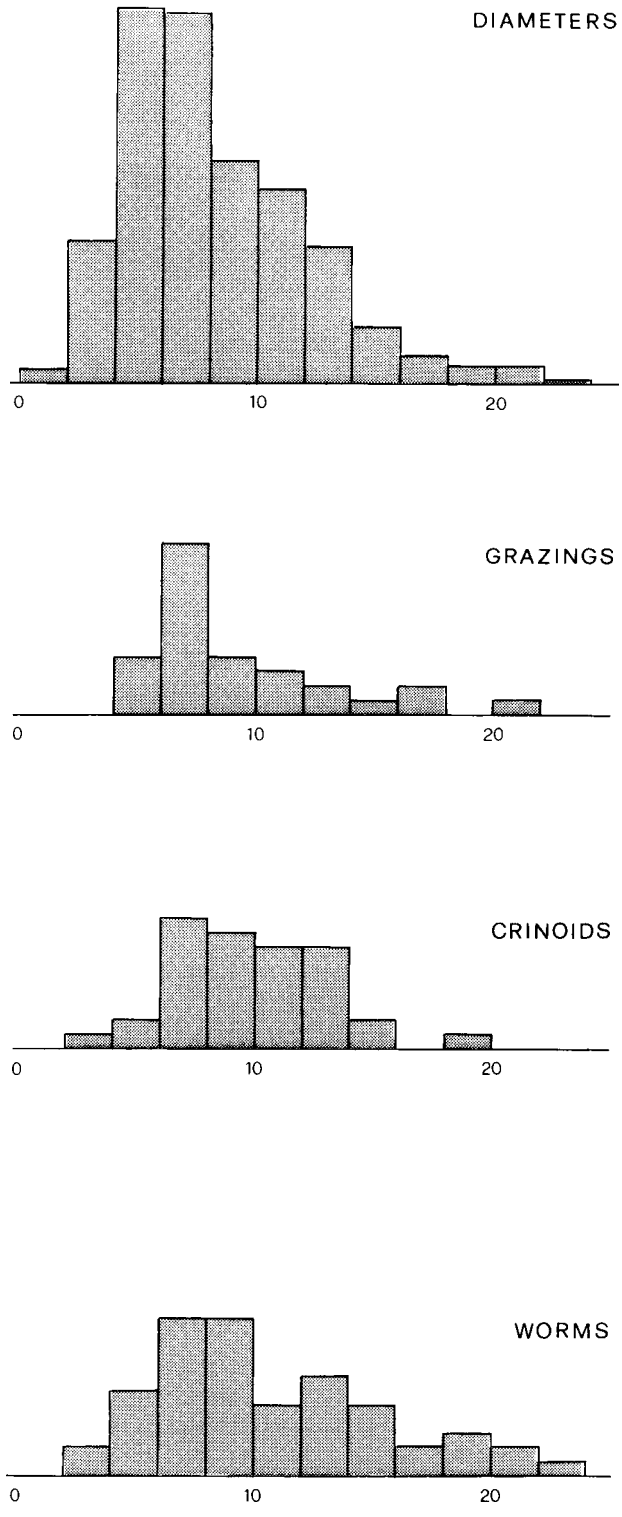
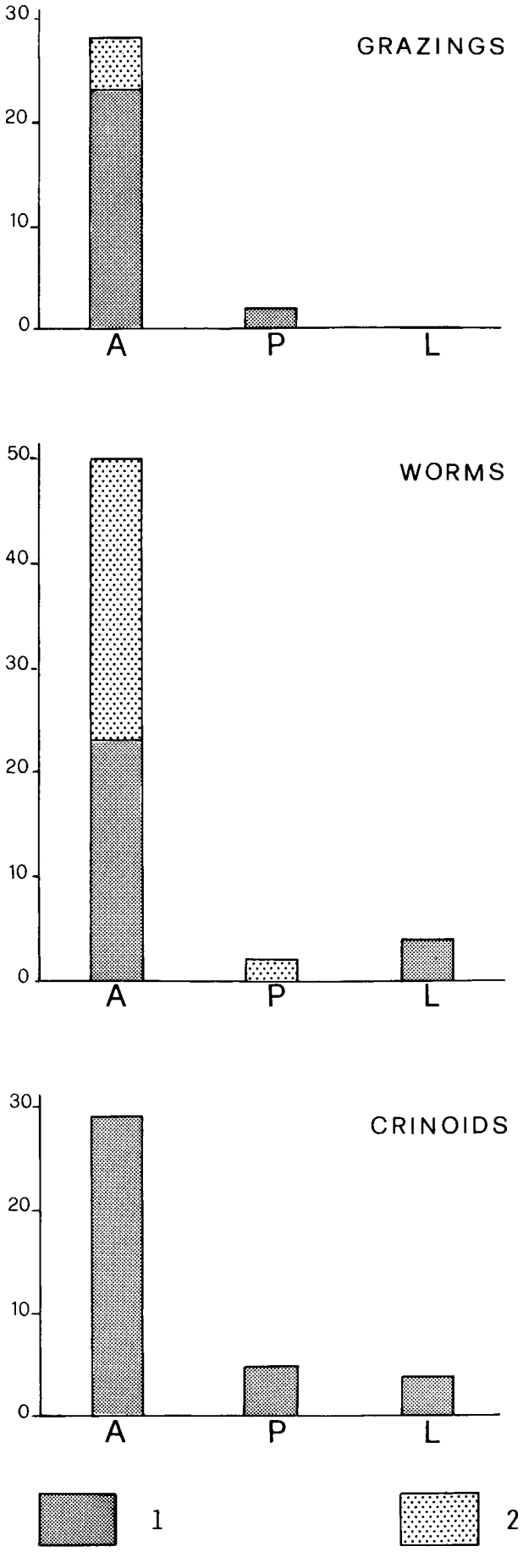


FIG. 1 — Histograms showing the ratios existing among Kimmeridgian ammonites diameter and the number of epizoans and trace fossils. In order to achieve more compactness in the histograms two centimeters wide dimensional classes have been used.

Istogrammi che mostrano i rapporti esistenti tra i diametri delle ammoniti kimmeridgiane e gli epizoi e le tracce fossili. Per rendere la rappresentazione più compatta sono state usate classi dimensionali di due centimetri di ampiezza per i diametri delle ammoniti.



extremely rare. On the contrary the superimposion of crinoids and worms on not grasped ammonites, is more frequent. The datum let to think that worms and crinoids prefered to colonize ammonites not covered by algal film or that this phenomena happened in different moments or during different environmental fluctuations.

Lack of grazing traces on Lytoceratids (Figs. 2-4) may be attributed as a hypothesis, to a different hydrodinamic response to the reworking of this type of ammonites, after the epizoans action (overturning impossibility; more sediment in the ombilics). On the other hand the percentage of presence of the other epizoans, equivalent in respect to the other forms, makes this hypothesis not much credible.

— Further analysis concern possible differences or similitudes in orientation or preferential disposition of the encrusters and grazers traces on ammonite shells. Four outlines have been individuated, corresponding to four types of enrolement: cadicone, evolute serpenticone, platicone, serpenticone. On this outlines we reported the symbols of the various epizoans and grazers traces considering all the ammonites as they had the same diameter (Fig. 4). The distribution of encrusting or grasping organisms shows neither particular orientation nor preferencial disposition sites, partially in contrast with Jolly (1976). The only distribution apparently showing a preferential disposition is the grazing frequency where ribs and spines there are (Pl. I; Figs. 7, 8).

The last analysis regards presence and importance of shell borers (clionid sponges or polychaetes or boring algae). We have examined many shells of different types in thin section and we have never found boring traces in grasped shells. On the contrary in some particular lenses of detrital material coarse sand-size shell fragments are bored and almost completely destroyed. These observations can not be considered of statistical value but their number, some tens, seems sufficient to affirm that in our fossil site boring organisms acted in a following stage to the one of echinoids, crinoids and worms. Presence of borersin skeletal debris is also useful to demostrate that, when they are present, they are perfectly recognizable after complete diagenetic processes too.

Conclusions

By the study of fossil traces and encrusting organisms we obtained two kinds of results.

— Firstly we can state, with a reasonable certainty, there are differences in the action of grazing and colonizing organisms among cadicone ammonite

FIG. 2 — Histograms showing the frequency of epizoans and trace fossils on the three suborders of Kimmeridgian ammonites. A - Ammonitina; B - Phylloceratina; C - Lytoceratina - 1 - outside the shell; 2 - inside the shell.

— Istogrammi che mostrano la frequenza di epizoi e tracce fossili sui tre sottordini di ammoniti kimmeridgiane. A - Ammonitina- B - Phylloceratina; C - Lytoceratina; 1 - esterni al guscio; 2 - interni al guscio.

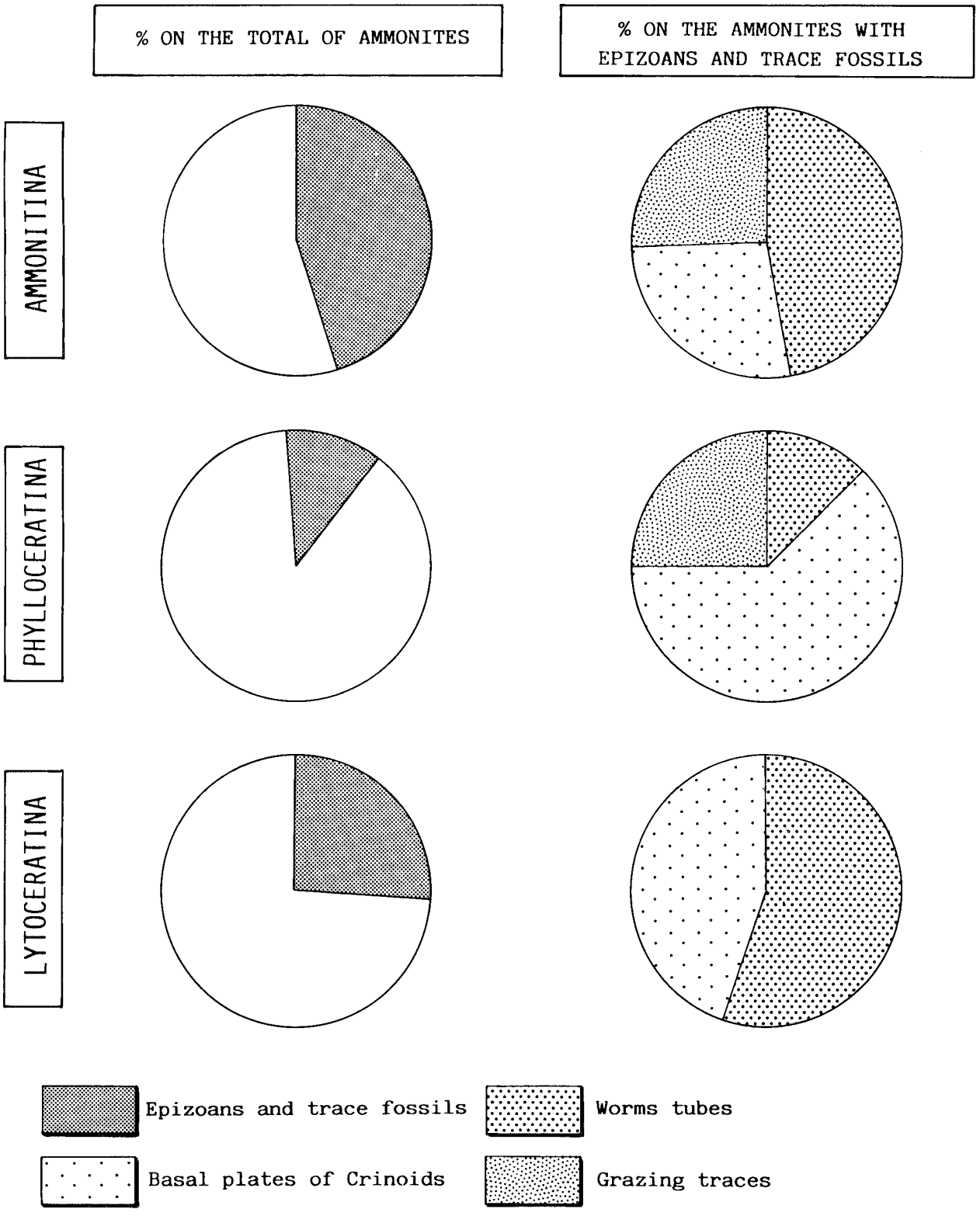


FIG. 3 — Circular graphics showing the percentages of kimmeridgian ammonites with epizoans and trace fossils. Data are divided in three suborders in which these ammonites are distributed. Graphics on the left show the percentage calculated on the entire amount of specimens; graphics on the right show the percentage calculated on the entire amount of specimens with epizoans and traces.

Grafici circolari che mostrano le percentuali di ammoniti kimmeridgiane che presentano epizoi e tracce fossili. I dati sono suddivisi nei tre sottordini a cui le ammoniti sono state attribuite. I grafici sulla sinistra rappresentano la percentuale di ammoniti con epizoi e tracce fossili calcolata rispetto al numero totale degli esemplari. I grafici sulla destra rappresentano le singole percentuali degli epizoi e tracce fossili rispetto al totale degli esemplari su cui esse sono state rinvenute.

shells and platicone and serpenticone ones. We know that echinoids graze practically all the clean bottom rocks in the today seas, so the above mentioned difference must be explained.

The difference in the grazzers action does not seem related to the presence of borers and it seems more probable that echinoids grasp the algal film on the shells. If this is true we could think either that

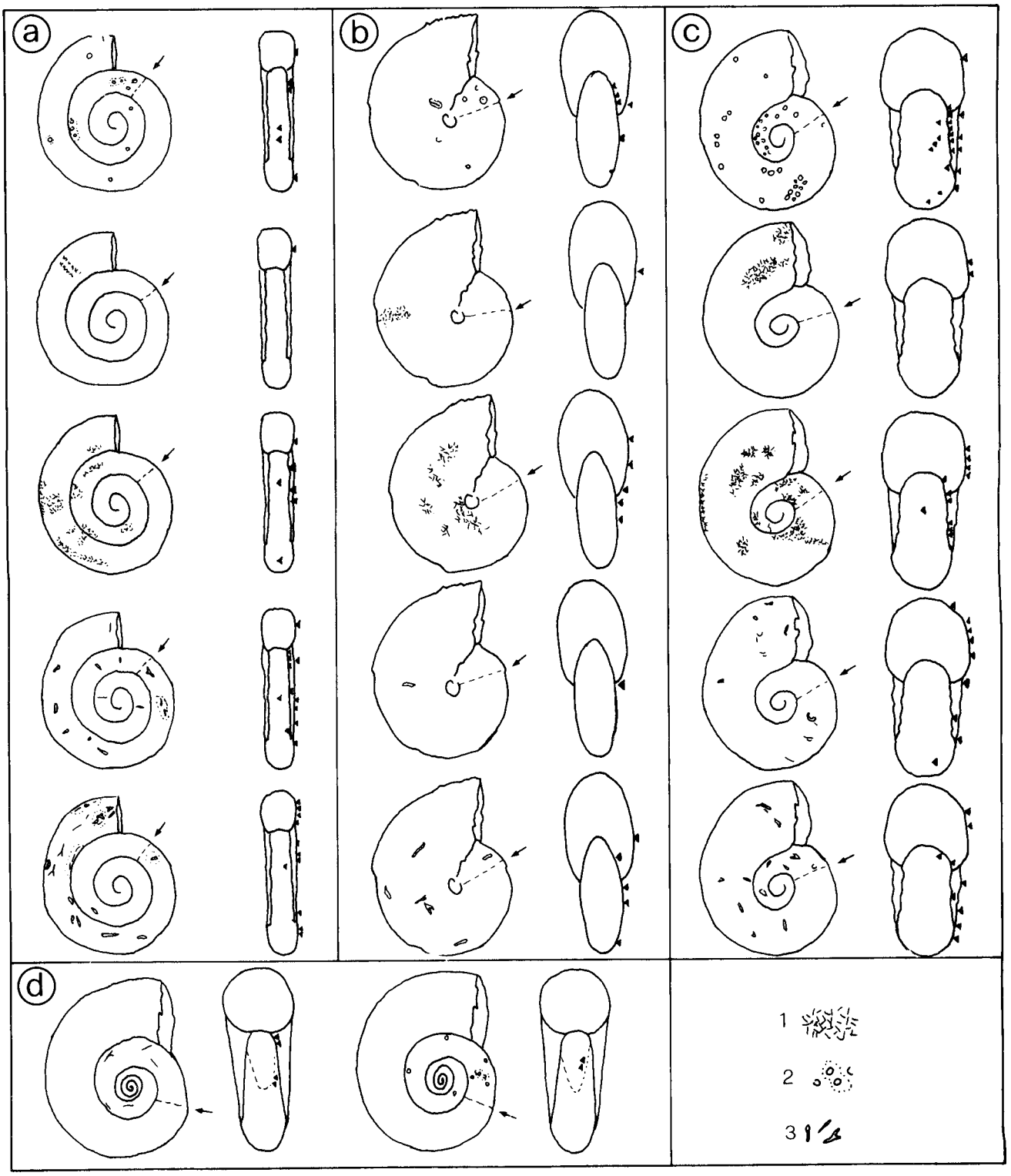


FIG. 4 — Distribution of "grazing" traces, crinoid basal disks and sedentarid worms tubes on four morphological groups of ammonites. The arrows show the beginning of the living chamber. a - evolute serpenticone; b - platicone; c - serpenticone; d - cadicone; 1 - "grazing traces"; 2 - crinoid disks; 3 - tubes of worms.

— Distribuzione delle tracce di graspamento, dei dischi di ancoraggio di crinoidi e dei tubi di vermi sedentari sui quattro gruppi morfologici di ammoniti. Le frecce indicano l'inizio della camera di abitazione. a - serpenticono evoluto; b - platicono; c - serpenticono; d - cadicono; 1 - tracce di graspamento; 2 - dischi di crinoidi; 3 - tubi di vermi sedentari.

algae, crinoids and worms preferentially colonized some types of ammonites after the death, perhaps for the different mineralogical type of shell or for other reasons, today unknown; or, more probably, that some Ammonitina lived near the sea bottom and were covered by algal film and perhaps by epizonans, during their life. On the contrary, other ammonites, Phylloceratids and Lytoceratids, truly nectonic should be less attacked by vegetation, boring and encrusting organisms. The second hypothesis seems to be preferable according to the results of the studies of CHAMBERLAIN *et alii* (1981) who show the cadicone ammonites to be less suitable to a nectonic way of life than other shape groups. In this case the pre-burial stage could have been too brief for the development of algae and for the subsequent action of grazers. From this stand point the grazer's action should have been limited to the specimens already covered by vegetation during an epibenthic life. As we know many living organisms have tropic relations with different kinds of shells to which they adapted, so we can hypothesize a similar phenomenon in the past. Then echinoids in this environment in which soft bottoms were widespread may also developed particular tropic relations with ornated and food-richer shells of epibenthic ammonites. For istance living echinoids are able to "recognize potential food at a distance using chemosensory receptors" (SMITH, 1984; p. 52); in this way the differences in grazing action could rise more and more.

Second, from a paleoenvironmental point of view, we can state that, during Kimmeridgian, at least locally, in our region lived a rich fauna of regular echinoids adapted to grasp algal film, in spite of the fact that fossils of this kind are practically missing in our outcrops. But also this datum is well known (ROMAN, 1984). The relatively scarce presence of regular echinoids according to KIER (1977) may be related to they live as epifauna and they are exposed to meccanical and biological etching. Anyway such information requires further indications and seems to be more important from a paleobiogeographic point of view.

Echinoids are not parassitic benthic forms and their distribution is related both to the larval dispersion and to the possility that larvae found an adapt environment before the end of their brief free-swimming stage.

Then we can conclude that an algal flora of some importance was present at least in some sites in our area during Late Jurassic and that the sediment-water interface, in this sites, must have been into the fotic and phytal zone. We know other similar phenomena in other outcrops in Central Italy, so these sites had to be at relatively short distance among them too. This is in accord with the results obtained by precedent works (NICOSIA & PALLINI, 1977; MARIOTTI *et alii*, 1979; FARINACCI *et alii*, 1981). These sites must have persisted at least during Kimmeridgian since an environment where a particular fauna lives certainly is more persistant than the fauna itself. For the lack of rocky bottoms only the skeletal fragments were available for the colonization by algae, crinoids, worms and later for the grazers. By these data we could image that large amount of unconsolided, at various times suspended, ooze could have been the limitant factor to the establishing of an eulitoral facies and that the grazer's action helped in that direction destroiing each first algal settlement and the hardning of the bottom.

Acknowledgments. Thanks are due to A. Farinacci and to T. Kotsakis for reading the paper, to R. Rampini for measuring and examining the material during his graduation work and to M. Albano that helped in the preparation of drawings.

RIASSUNTO

In questo lavoro sono stati studiati ed analizzati statisticamente i rapporti tra ammoniti ed epizoi, provenienti da un affioramento di età kimmeridgiana dell'Appennino Centrale. I risultati ottenuti, come mostrato dai grafici, permettono di differenziare per due gruppi di cefalopodi, uno composto da Phylloceratidi e Lytoceratidi, l'altro da Ammonitidi, una differente attività degli epizoi. Tale attività risulta essere avvenuta dopo la morte o in prima deposizione o dopo un periodo di seppellimento e dopo esumazione. Tale diversa attività, che non trova riscontro nel modo di vita degli attuali echinoidi, è quindi attribuibile al differente modo di vita delle ammoniti e al fatto che alcune di esse (Ammonitina) erano già coperte da un velo algale prima della morte mentre le altre (Phylloceratidi e Lytoceratidi) dovettero avere un periodo post-mortem e pre-seppellimento troppo corto per poter essere coperte dalle alghe.

Manoscritto presentato il 12 gennaio 1987

REFERENCES

BREIMER A. (1978) — Ecology and paleoecology. In: Part. **T** Echinodermata 2 Crinoidea. Treatise on Invertebrate Paleontology, **1:** 316-343, Boulder.

BREIMER A. & WEBSTER G.D. (1975) — A further contribution to the paleoecology of fossil stalked crinoids. *Proc. Konink. Nederland. Akad. Wetensch.*, **78** (2): 149-167, Amsterdam.

BROMLEY R.G. (1975) — Comparative anlysis of fossil and recent echinoid bioerosion. *Paleontology*, **18:** 725-739, London.

CECCA F., CRESTA S., PALLINI G. & SANTANTONIO M. (1985) — Remarks on the Kimmeridgian - Lower Tithonian ammonite biostratigraphy of two sections in the Central Apennines (Italy). *Newsl. Stratigr.*, **15** (1): 28-36, Berlin.

CECCA F. & SANTANTONIO M. (1982) — Osservazioni preliminari sulla fauna ad ammoniti del Kimmeridgiano-Titonico di Monte Lacerone (Sabina-Appennino Centrale). *Quad. Paleontol. Stratigr. Evol.*, **2:** 63-69, Roma.

CHEMBERLAIN J.A. jr., WARD P.D. & SCOTT WEAVER J. (1981) — Post-Mortem ascent of *Nautilus* shells: implications for cephalopod paleobiogeographi. *Paleontology*, **7** (4): 494-509, Tulsa.

FARINACCI A. (1967) — La serie Giurassico-Neocomiana di Monte Lacerone (Sabina). Nuove vedute sull'interpretazione paleogeografica delle aree di facies Umbro-Marchigiana. *Geol. Romana*, **6:** 421-480, Roma.

FARINACCI A., MARIOTTI N., NICOSIA U., PALLINI G. & SCHIAVINOTTO F. (1981) — Jurassic sediments in the Umbrian-Marchean Apennines: an alternative model. In: FARINACCI A. & ELMI S. (Eds): Rosso Ammonitico Symposium, Proc. Edizioni Tecnoscienza, 335-398, Roma.

FURSICH F.T. & WENDT J. (1977) — Biostratinomy and palaeoecology of the Cassian Formation (Triassic) of the Southern Alps. *Palaeogeogr., Palaeoclimatol., Palaeoecol.*, **22:** 257-323, Amsterdam.

GAETANI M. & FANTINI SESTINI N. (1978) — La zona a Margaritatus (Domeriano) nella successione dell'Alpe Turati (Como). *Riv. Ital. Paleont.*, **84** (3): 531-560, Milano.

GYGI R.A. (1986) — Eustatic sea level changes of the Oxfordian (late Jurassic) and their effect documented sediments and fossil assemblages of an epicontinental sea. *Eclogae Geol. Helv.*, **79** (2): 455-491, Basel.

JOLY B. (1976) — Les Phylloceratidae Malgaches au Jurassique. Béneralités sur les Phylloceratidae et quelques Juraphyllitidae. *Docum. Lab. Geol. Fac. Sci. Lyon*, **67:** 1-471, Lyon.

KABAMBA M. & TINTANT H. (1983) — Rapports entre l'évolution des nautiloidés post-triassiques et leur mode de vie. Résumés du premier Congrès International de Paléoécologie, Lyon.

KIER P.M. (1977) — The poor fossil record of the regular echinoid. *Paleobiology*, **3:** 168-174, Menlo Park (Calif.).

KUSS S.E. (1963) — *Cyrtocrinus nutans* (GOLDFUSS) als Ammoniten-Epoeke im Malm alpha von Blumberg (Baden). *Ber. Naturf. Ges. Freiburg i. Br.*, **53:** 205-212, Freiburg i. Br.

LANGE W. (1932) — Ueber Symbiosen von *Serpula* mit Ammoniten in Unteren Lias Norddeutschland. *Z. Deutsch. Geol. Ges.*, **84:** 229-234, Stuttgart.

LOMINADSE T.A. (1983) — Paleoecology of the Callovian Ammonitida of the Northern Caucasus. Résumés du premier Congrès International de paleoecologie, 097, Lyon.

MARCHAND D. (1984) — Ammonites and paleoenvironments: a new approach. *Geobios*, Mém. Spécial, **8:** 101-108, Lyon.

MARIOTTI N., NICOSIA U., PALLINI G. & SCHIAVINOTTO F. (1979) — Kimmeridgiano recifale presso Case Canepine (M. Martani, Umbria): ipotesi paleogeografiche. *Geol. Romana*, **18:** 295-315, Roma.

MERKT J. (1966) — Ueber Austern und *Serpula* als Epoeken auf Ammonite Gehaeusen. *N. Jh. Geol. Palaeont. Abh.*, **125:** 467-479, Stuttgart.

NICOSIA U. & PALLINI G. (1977) — Hermatypic corals in the Tithonian pelagic facies of Central Apennines. Evidence of Upper Jurassic sea level changes. *Geol. Romana*, **16:** 243-261, Roma.

ROMAN J. (1984) — Les échinides et les milieux de vie du Tertiaire. Quelques exemples. *Geobios*, Mém. Spécial, 8: 115-124, Lyon.

SANTANTONIO M. (1985) — Ammoniti rare della famiglia Haploceratidae nel Malm dell'Appennino Umbro-marchigiano-Sabino. *Geol. Romana*, **22** (1983): 147-155, Roma.

SCHINDEWOLF O.H. (1950) — Grundfragen der Palaeontologie. Schwet. verlager, Stuttgart.

SCOTT G. (1940) — Paleoecological factors controlling the distribution and mode of life of Cretaceous ammonoids in the Texas area. *J. paleont.*, **14** (4): 299-323, Tulsa.

SIEVERLS H. (1932) — Kolonien von *Cotylederma lineati* QUENSTEDT (crinoidea) aus dem sueddeutschen Lias. *Paleont. Z.*, **14:** 96-107, Berlin.

SMITH A. (1984) — Echinoid palaeobioogy. Special Toics in Palaeontology, **1:** 1-190, Allen & Unwin Ltd., London.

TANABE K. (1979) — Paleoecological analysis of ammonoid assemblages in the Turonian Scaphites facies of Hokkaido, Japan. *Palaeontology*, **22:** 609-630, London.

VERMEIJ G.J. (1977) — The Mesozoic marine revolution: evidence from snails, predators and grazers. *Paleobiology*, **3:** 245-258, Menlo Park (Calif.).

WARD P. (1986) — Cretaceous ammonite shell shapes. *Malacologia*, **27** (1): 3-28, Philadelphia.

ZIEGLER B. (1967) — Ammoniten-Oekologie am Beispiel des Ober-Jura. *Geol. Rundsch.*, **56:** 439-464, Stuttgart.

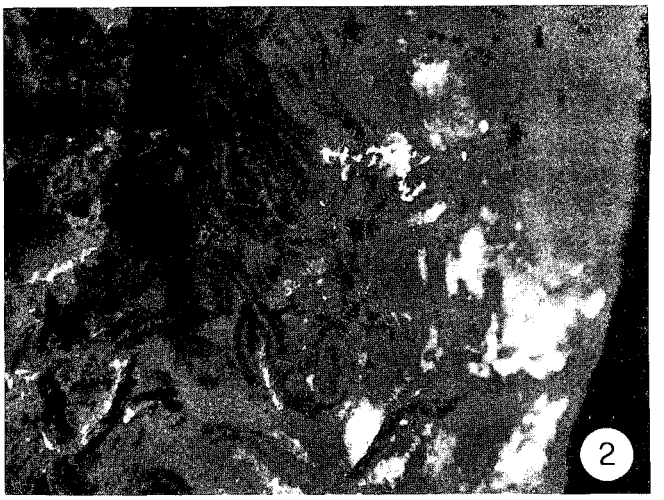
PLATE I

Fig. 1 - Tubes of sedentarid worms outside the shell of a *Lytoceras* sp.
Fig. 2 - Worms traces inside the shell of a *Lytoceras* sp.
Fig. 3 - Group of crinoid disks, different in sizes, on *Nebrodites* sp.
Fig. 4 - Crinoid disks on *Aspidoceras* sp.
Fig. 5 - Grazing traces on shell of *Hybonoticeras* sp.
Fig. 6 - Grazing traces as mould on the sediment filling the living chamber of an ammonite.
Fig. 7-8 - Grazing traces on a rib and knobs of *Taramelliceras* sp.

TAVOLA I

Fig. 1 - Tubi di vermi sedentari sul guscio di un esemplare di *Lytoceras* sp.
Fig. 2 - Tracce di vermi sedentari internamente al guscio di *Hybonoticeras* sp.
Fig. 3 - Dischi di crinoidi, di diverse dimensioni, su *Nebrodites* sp.
Fig. 4 - Dischi di crinoidi su *Aspidoceras* sp.
Fig. 5 - Tracce di graspamento sul guscio di *Hybonoticeras* sp.
Fig. 6 - Calchi di tracce di graspamento nel sedimento che riempie la camera di abitazione di un'ammonite.
Fig. 7-8 - Tracce di graspamento su una costa e su nodi di *Taramelliceras* sp.

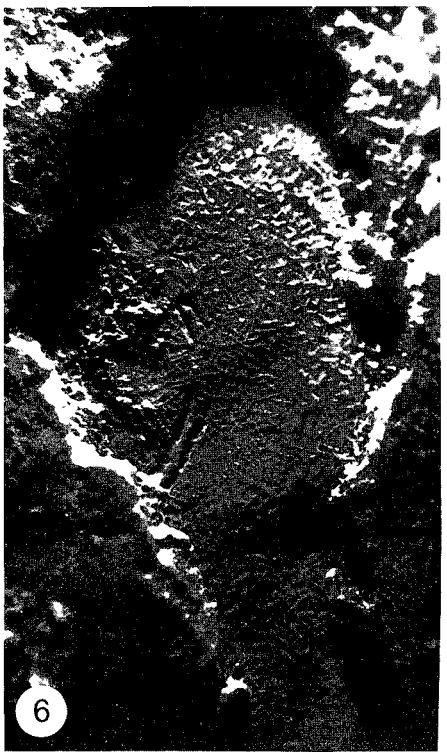

1


2


3


4


5


6


7


8