

Accumulation: taphonomic concept and other palaeontological uses

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INTRODUCTION

The amount of taphonomic terms has quickly grown during the last decades. Many descriptive terms have been incorporated into the taphonomy, from the ordinary language or from related scientific fields. The current meaning of some taphonomic terms is intuitive, but clearly diverse as used by different authors, in absence of information on original proposition or usage and historical development. The aim of the present work is to review most common meanings in taphonomy of the term "accumulation", offering alternative terms in order to avoid current mistakes with other palaeontological concepts.

TAPHONOMIC ACCUMULATION

Taking into account the most common meaning in everyday use, "accumulation" may be also employed in taphonomy as a technical term to denote growing in amount or number, by addition of palaeobiological information or taphonomic enti-

ties. In this respect, considering a particular place or area, the addition of palaeobiological information or taphonomic entities may be by autochthonous biogenic production or by allochthonous biogenic production and importation. Nevertheless, in a broad sense, this term denote the action or process of adding palaeobiological information or taphonomic entities (*e.g.*, preserved elements or preserved-associations) from biosphere into the lithosphere. The following expressions and sentences, obtained from the GeoRef database searching by the term "accumulation", illustrate this taphonomic meaning:

- 1) *Monkey-eating eagles as agents of bone accumulation...*
- 2) *The process of accumulation of a fossil assemblage from the original fauna...*
- 3) *A mass-accumulation of vertebrates...*
- 4) *Existing literature suggests that catastrophism was not responsible for the accumulation of bones.*
- 5) *... the assemblage accumulated in a distal floodplain lake, which served as a natural death trap....*
- 6) *...estimated rates of accumulation of foraminiferal lutite, and the composition of planktic foraminiferal faunas in cores...*
- 7) *Processes controlling the accumulation of diatoms in sediments...*
- 8) *Abundant Nothofagus pollen suggests accumulation under cool or even glacial climatic conditions.*
- 9) *Epochs of intensive accumulation of plankton in the history of the Earth and their causes.*
- 10) *Greater rate of scar accumulation with increasing shell size among Recent naticids reflects increase in breakage-localizing shell thickness since the Miocene.*
- 11) *Microboring spuren in selected accumulation areas of European Jurassic...*
- 12) *Excellent preservation of the sclerites, absence of epibionts, and minimal internal sediment within the "pockets" suggest rapid accumulation.*

Efremov (1940, 1950) stated that "the chief problem of this branch of science is the study of the transition (in all its details) of animal remains from the biosphere to the lithosphere". The term "accumulation" was proposed by Efremov (1950: 94; Fig. 29) to refer the first stage in the formation of fossil lagerstätten. This taphonomic term may be currently employed to denote the incorporation into the lithosphere of palaeobiological information (that is, either of biological information, or of biogenically produced, taphonomic entities). This transference of palaeobiological information, from biosphere to lithosphere, may or may not be associated to a transference of palaeobiological material, and it does not imply sedimentation processes. In this respect, any fossil had to be accumulated into materials of the lithosphere, but it did not need to be sedimented after being biogenically produced (Fernández López, 1984:216; 1988:23; 1991). Consequently, the taphonomic meaning of the

term accumulation is not synonymous of sedimentation. On the other hand, after being accumulated, two other taphonomic processes may affect the preserved elements (*i.e.*, biogenic remains and traces) namely: resedimentation and reelaboration. Taphonomic resedimentation means the displacement along the floor, prior to the burial, of previously accumulated elements. In contrast, taphonomic reelaboration or taphonomic reworking means the exhumation and displacement on the floor of taphonomic elements. Both, resedimentation and reelaboration processes may be iterative and generate different degrees of taphonomic removal. But none of these three processes necessarily means lateral transport on the floor, and each of them may occur in the very same place where the corresponding taphonomic element was produced. As a consequence of these three general modalities of transference of palaeobiological matter and/or information, the different mechanical states of preservation in which taphonomic elements or present-day fossils may occur are only three: accumulated, resedimented and reelaborated.

In conclusion, the term "taphonomic accumulation" should be used to denote the processes of incorporation into the lithosphere of palaeobiological information or taphonomic entities, added or formed by biogenic production. A related sense of the term accumulation is to denote the result, effect or state of being accumulate(d). An accumulated fossil or element is a taphonomic element which has not been removed (*i.e.*, which has not been resedimented or reelaborated) during fossilization. In contrast, a non-accumulated fossil or element is a removed (resedimented or reelaborated) fossil or element. Accepting these two technical senses of the term taphonomic accumulation, it should be noted, however, that these processes and results must be interpreted by means of taphonomic and palaeobiological concepts, therefore by palaeontological reasoning, and not exclusively through taphonomic observations. Recent papers about the biochronological utility of these taphonomic concepts have been published by Martire & Pavia (1996), Denys *et al.* (1997), Fernández López (1997, 2000), Meléndez *et al.* (1997), Pavia & Martire (1997).

This meaning of the term "taphonomic accumulation" should not be confused with other palaeontological concepts such as: time averaging or taphonomic condensation, taphonomic clustering, abundance, concentration, fossil-lagerstätte, taphofacies, assemblage or preserved-association.

TIME AVERAGING OR TAPHONOMIC CONDENSATION

In taphonomy, accumulation should be distinguished from time-averaging or condensation. Bringing taphonomic elements closer together, either by taphonomic removal (*e.g.*, taphonomic resedimentation, reworking or reelaboration of taphonomic elements), by removal of sedimentary matrix (*e.g.*, biogenic reworking, bioturbation) or by very low or null rate of net accumulation of sediments (*e.g.*, sedimentary condensation, sedimentary starving) has been referred with the terms "taphonomic condensation" and "time averaging". The following expressions and

sentences illustrate the use of the term "accumulation" in the sense of time averaging and taphonomic condensation:

- 1) *Time-averaging leads to accumulation of taxa over time...*
- 2) *...fluorine dates on bones suggest a long period of accumulation.*
- 3) *...thin shell pavements record "background" periods of time-averaged skeletal accumulation...*
- 4) *The effects of the time-accumulation on metric variation in fossil samples.*
- 5) *...reworking more satisfactorily explains the presence of the mixed fauna than concentration of forms due to accumulation over a long period of time in a basin of nominal sedimentation.*

The term "condensation" has been employed in palaeontology to refer the process of mixture of temporary successive remains and/or traces of palaeobiological entities. This process and its results have been mentioned with distinct terms such as: "faunal condensation" (Fürsich, 1978) or "taphonomic condensation" (Fernández-López, 1984, 1991; Gómez & Fernández López, 1994). Taphonomic condensation produces condensed fossil assemblages or condensed associations. The degree of taphonomic condensation of an assemblage can be expressed by the number of chronostratigraphic or biostratigraphic units represented by the fossils of the assemblage. Other related concepts are: degree of removal (*i.e.*, the ratio of reelaborated and resedimented elements to the whole) and degree of taphonomic heritage (*i.e.*, the ratio of reelaborated elements to the whole) of a fossil assemblage or a preserved-association (Fernández-López, 1995, 2000; Fernández-López & Meléndez, 1995). Taphonomic processes of condensation should be distinguished of stratigraphic or sedimentary condensation (Fernández-López & Gómez, 1991; Gómez & Fernández López, 1994). Stratigraphic condensation is the process of formation of rock bodies thinner than others of an equivalent time-interval as a consequence of a low to zero sedimentation rate. When decreasing thickness is due to lower net accumulation rate of sediment, the process is sedimentary condensation.

"Time-averaged" was coined by Walker & Bambach (1971) to denote benthic assemblage that neither transported nor mixtures of indigenous and transported material, but instead "accumulate from the local living community during the time required to deposit the containing sediment". Time averaging refers to the mixing of skeletal elements of non-contemporaneous populations or communities (Fürsich, 1990: 237). Different relative degrees of time-averaging have been categorized by Kidwell & Bosence (1991) as census, within-habitat time-averaged, environmentally condensed, and biostratigraphically condensed. Kidwell & Behrensmeier (1993) have remarked the following definition of time-averaging: "The process by which organic remains from different time intervals come to be preserved together..., that is a progressive process resulting from generation times typically being short relative to net rates of sedimentation accumulation, and/or mixing depths being large

relative to sediment accumulation". Recent papers about these concepts have been published by Kowalewski (1996), Kidwell (1998), Kowalewski *et al.* (1998), Olszewski (1999).

In short, the terms "time averaging" and "taphonomic condensation" may be employed in palaeontology to refer the process of mixture of remains or traces of chronologically successive palaeobiological entities. According to the current usage, taphonomic condensation is an extreme case of time averaging, involving taphonomic elements of several biochronological or geochronological units.

TAPHONOMIC CLUSTERING, TAPHONOMIC REGROUPING

Other taphonomic processes or actions that should be distinguished from accumulation lie in bringing to a point, forming a group, joining together taphonomic entities. Also, to aggregate taphonomic entities to an amount, or to bring closer together taphonomic entities, by a combination or sum of several processes or actions into one. The following expressions and sentences illustrate the use of the term "accumulation" in the sense of taphonomic clustering or taphonomic regrouping:

- 1) *Flume studies on the orientation, accumulation and burial of biogenic particles...*
- 2) *Pellet and bone accumulation at a colony of western gulls...*
- 3) *Baffling, binding or debris accumulation...*
- 4) *This deposit is interpreted to have originated by the lateral coalescing of more abrupt individual algal build-ups that formed by essentially in situ clastic accumulation of algal fragments within a relatively turbulent marine environment.*
- 5) *Accumulation of the diatomaceous material was not due to normal processes of sedimentation, but to the action of strong marine currents which had transported the material from its original environment.*
- 6) *... this fossil assemblage formed first from gradual accumulation of bone, shell and sediments on a barrier island beach.*

A geological term related to this meaning of accumulation is "packing"; *i.e.*, "the manner of arrangement or spacing of the solid particles in a sediment or sedimentary rock, ...; specif. the arrangement of clastic grains..." (Bates & Jackson, 1987). And, from a descriptive point of view, several related indices or attributes of the taphonomic elements have been distinguished (Bates & Jackson, 1987; Fernández Lopez, 2000); for example:

- "clustering geometry" (pavement, stringer, lenticular; current shadow, gutter fill, burrow fill, fissure fill, storm concentration, winnowed concentration, others),
- "clustering pattern of taphonomic elements" (original, modified; imbricated, in chain, in arrow shape, in "T" shape, encased, others),

"packing degree" (number of specimens minus number of fossiliferous levels divided by number of fossiliferous levels),

"packing density"(relative volume occupied by taphonomic elements to the total volume of the rocky body),

"packing proximity" (number of taphonomic elements that are in contact with their neighbours by surface or volume unit)

In order to avoid current mistakes with the concept of accumulation in this sense, from a taphonomic point of view, it is useful to employ the terms "taphonomic regrouping" or "taphonomic clustering" to refer the process of grouping again or differently taphonomic elements (Fernández López, 2000).

ABUNDANCE

The term accumulation has been employed to denote a feature, state or condition of taphonomic entities, as a synonym of abundance. In this respect, this concept denotes a feature, not a process or action. Abundance is the amount or number of taphonomic elements. Also, a large quantity or number of taphonomic elements. For example, in the following expressions or sentences:

- 1) *The most likely main cause of the dense accumulation was hyena denning activity.*
- 2) *The great accumulation of mammoth bones at...*

"Density of the preserved association" is another term to specify the number of preserved elements by surface or volume unit in the area occupied by the association. The term accumulation has also been used as a feature of deposits or rocks; *i.e.*: the amount or number of taphonomic elements per unit surface or volume of a deposit or rock. For example: *The dense bone accumulation of this layer almost certainly did not arise by the action of floods.*

CONCENTRATION

Accumulation has been employed as synonym of concentration, a feature, state or condition of taphonomic entities. In particular, to denote the total volume of taphonomic elements. Also, a high volume of taphonomic elements, as well as the state of being concentrate or aggregate. For example: *The accumulation of siliceous fossils and the origin of siliceous nodules...*

The term accumulation has also been used as a feature of deposits or rocks; *i.e.*: the volume of taphonomic elements per unit volume of a deposit or rock. For example: *... lithographic limestones of the uppermost Jurassic at Solnhofen (Bavaria) are formed from an accumulation of coccoliths and coccolith debris.*

FOSSIL-LAGERSTÄTTEN OR TAPHOFACIES

The term accumulation has been employed also as a synonymous of fossil-lagerstätte or (tapho)facies. For example, in the following expressions or sentences:

- 1) *The goniatite bed is shown to be an accumulation of randomly oriented, hollow, or spar-filled goniatite shells of several species in a matrix of calcilutite.*
- 2) *Most of the bones occur as disarticulated and broken elements in multitaxa, bonebed-type accumulations within shallow depressions scoured into the underlying alluvium.*
- 3) *Taphonomy of the large, living fusiform foraminiferan Alveolinella; implications for the accumulation of alveolinid and fusulinid limestones.*
- 4) *Stratigraphic patterns of fossil accumulations...*
- 5) *Unusual coquina-like accumulation of aquatic fossils from...*
- 6) *... for interpreting the mode of accumulation of fossil plant beds...*

Fossil-lagerstätten are rock bodies unusually rich in palaeontological information, either in a quantitative or qualitative sense (Seilacher *et al.*, 1985). A fossil-lagerstätte is any rock containing fossils which are sufficiently well preserved and/or abundant to warrant exploitation, if only for scientific purposes (Seilacher, 1996: 266). Taphofacies, or taphonomic facies, consist of suites of sedimentary rock characterized by particular combinations of preservational features of the contained fossils; defined on the basis of consistent preservational features (Brett & Speyer, 1996: 258).

ASSEMBLAGE OR PRESERVED-ASSOCIATION

An "accumulation" has been understood by many authors as an assemblage, an aggregate or collection of taphonomic elements, as well as a taphonomic entity. For example:

- 1) *Accumulations of Nummulites tests in Eocene limestone... exhibit an unusual arrangement, whose pattern is attributed to the action of currents.*
- 2) *Origin and Paleoecology of free-rolling oyster accumulations (ostreoliths)...*
- 3) *An accumulation encountered in a borehole has permitted a differentiation of the lower Sarmatian.*

"Accumulation", "assemblage" and "taphonomic entity" have been considered as synonymous terms, but they are not. The term assemblage has several meanings (Fagerstrom 1964). According to some authors, assemblages consist of organisms

derived from more than one community (i.e. they exhibit signs of mixing). In another, broader definition, the term refers to any group of organisms from a geographical locality. An assemblage is "a group of fossils that occur at the same stratigraphic level; often with a connotation also of localized geographic extent" (Bates & Jackson, 1987). A fossil assemblage is any group of fossils from a suitable restricted stratigraphic interval and geographic locality. Assemblages of just one species are monotypic fossil assemblages (Fagerstrom 1964). Fossil assemblages comprise spatially associated fossils that became embedded together after biostratigraphic processes affected them and that were influenced by diagenetic processes (Fürsich, 1990: 237; Fürsich & Aberhan, 1990).

Taking into account the taphonomic postulate of emergence (Fernández-López, 1988, 1991, 2000), a logical assumption about the existence of hierarchically organized taphonomic systems, taphonomic entities may be elemental (*i.e.*, preserved elements) or supraelemental (*e.g.*, taphonic-populations or preserved-associations). Any taphonomic entity is an evidence of a palaeobiological entity. A preserved element is a remain and/or trace which is (para)taxonomically meaningful and determinable. A taphonic population, or taphopopulation, is a group of preserved elements which represent the same taphon (or taphonomic group), being spatially differentiated. A preserved association may be understood as a group of interrelated elements of two or more taphonomic groups (or tapha).

CONCLUSIONS

Taphonomic accumulation denote the processes of incorporation into the lithosphere of palaeobiological information or taphonomic entities, added or formed by biogenic production, as well as the taphonomic result, effect or state of being accumulate(d). To summarize arguments treated in the present work, the following palaeontological concepts and alternatives terms can be distinguished:

Alternative terms denoting processes and results, are time-averaging, taphonomic condensation, and taphonomic clustering or regrouping. *Time averaging* refers the process of mixture of remains or traces of chronologically successive palaeobiological-entities. According with the current usage, *taphonomic condensation* is an extreme case of time averaging, involving taphonomic elements of several biostratigraphical or geochronological units. *Taphonomic clustering* or *taphonomic regrouping* refers the process of grouping again or differently taphonomic elements.

Alternative terms denoting a feature, state or condition of taphonomic entities, not a process or action, are abundance and concentration. *Abundance* is the amount or number of taphonomic elements per unit surface or volume of a deposit or rock. *Concentration* is the total volume of taphonomic elements per unit volume of a deposit or rock. *Density* of a preserved association is the number of taphonomic elements by surface or volume unit in the area occupied by the association.

Alternative terms denoting fossiliferous rocks are fossil-lagerstätte or (tapho)facies. A *fossil-lagerstätte* is any rock containing fossils which are sufficiently well preserved and/or abundant to warrant exploitation. *Taphofacies* are suites of rock characterized by particular combinations of preservational features of the contained fossils.

Alternative terms denoting aggregates or collections of taphonomic entities are assemblage and preserved-association.

SUMMARY

Different taphonomic meanings of the term "accumulation" are discussed and suggestions about alternative terms given. In accordance with the idea of taphonomy proposed by Efremov, the term "taphonomic accumulation" should be used to denote the processes of incorporation into the lithosphere of palaeobiological information or taphonomic entities, added or formed by biogenic production. By extension, this term may also denote the taphonomic result, effect or state of being accumulate(d). This meaning of the term "taphonomic accumulation" should not be confused with other palaeontological concepts such as: time averaging or taphonomic condensation, taphonomic clustering or regrouping, abundance, concentration, fossil-lagerstätte, taphofacies, assemblage or preserved-association.

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REFERENCES

- Bates, R.L. & Jackson, J.A. 1987. *Glossary of geology*. 788 pp. American Geological Institute, Alexandria, Virginia.
- Brett, C.E. & Speyer, S.E. 1996. Taphofacies. In: *Palaeobiology. A synthesis* (edited by Briggs, D.E. & Crowther, P.R.), pp. 258-263. Blackwell Science, London.
- Denys, C; Fernández-Jalvo, Y. & Laudet, F. 1997. Biochronology and taphonomy: problems and solutions. In: *Congrès BiochronM'97* (edited by Aguilar, J.P.; Legendre, S. & Michaux, J.), pp. 55-65. Institute Montpellier.
- Efremov, J. A. 1940. Taphonomy: new branch of paleontology. *Pan-American Geologist*, 74: 81-93.
- Efremov, J. A. 1950. Taphonomic et annales géologiques. *Annales du Centre d'Etudes et de Documentation Paléontologiques*, 4 (1953): 1-196.
- Fagerstrom, J.A. 1964. Fossil communities in Paleoecology: their recognition and significance. *Bulletin of the Geological Society of America*, 75: 1197-1216.

- Fernández-López, S. 1984. Nuevas perspectivas de la Tafonomía evolutiva: tafosistemas y asociaciones conservadas. *Estudios Geológicos*, 40 (1983): 215-224.
- Fernández-López, S. 1988. La Tafonomía: un subsistema conceptual de la Paleontología. *Coloquios de Paleontología*, 41 (1986-1987): 9-34.
- Fernández López, S. 1989. La materia fósil. Una concepción dinamicista de los fósiles. In: *Nuevas tendencias: Paleontología* (edited by Aguirre, E.), pp. 25-45. Consejo Superior de Investigaciones Científicas, Madrid.
- Fernández-López, S. 1991. Taphonomic concepts for a theoretical Biochronology. *Revista Española de Paleontología*, 6: 37-49.
- Fernández-López, S. 1995. Taphonomic et interpretation des paléoenvironnements. In M. Gayet & B. Courtinat (eds.): First European Palaeontological Congress, Lyon 1993. *Geobios*, M.S. 18: 137-154.
- Fernández-López, S. 1997. Fósiles de intervalos sin registro estratigráfico: una paradoja geológica. In: *Registros fósiles e Historia de la Tierra* (edited by Aguirre, E.; Morales, J. & Soria, D.), pp. 79-105. Editorial Complutense, Madrid.
- Fernández-López, S. 2000. *Temas de Tafonomía*. 167 pp. Depto. Paleontología, Univ. Madrid.
- Fernández-López, S. & Gómez, J.J. 1991. Condensación: significados y aplicaciones al análisis de cuencas. *Estudios Geológicos*, 47: 169-181.
- Fernández-López, S. & Meléndez, G. 1995. Taphonomic gradients in Middle Jurassic ammonites of the Iberian Range (Spain). In M. Gayet & B. Courtinat (eds.): First European Palaeontological Congress, Lyon 1993. *Geobios*, M.S. 18: 155-165.
- Fürsich, F.T. 1978. The influence of faunal condensation and mixing of the preservation of fossil benthic communities. *Lethaia*, 11: 243-250.
- Fürsich, F.T. 1990. Fossil concentrations and life and death assemblages. In: *Palaeobiology. A synthesis* (edited by Briggs, D.E. & Crowther, P.R.), pp. 235-239. Blackwell Science, London.
- Fürsich, F.T. & Aberhan, M. 1990. Significance of time-averaging for Paleocommunity analysis. *Lethaia*, 23: 143-152.
- Gómez, J.J. & Fernández-López, S. 1994. Condensation processes in shallow platforms. *Sedimentary Geology*, 92: 147-159.
- Kidwell, S.M. 1998. Time-averaging in the marine fossil record: overview of strategies and uncertainties. *Geobios*, 30: 977-995.
- Kidwell, S.M. & Behrensmeier, A.K. 1993. Introduction. In: *Taphonomic approaches to time resolution in fossil assemblages* (edited by Kidwell, S.M. & Behrensmeier, A.K.), pp. 1-8. Paleontological Society Short Courses in Paleontology, 6. The Paleontological Society, Iowa.
- Kidwell, S.M. & Bosence, D.W. 1991. Taphonomy and time-averaging of marine shelly faunas. In: *Taphonomy. Releasing the data locked in the fossil record* (edited by Allison, P.A. & Briggs, D.E.G.), pp. 115-209. Plenum Press, London.
- Kowalewski, M. 1996. Time-averaging, overcompleteness, and the geological record. *The Journal of Geology*, 104: 317-326.
- Kowalewski, M.; Goodfriend, G.A. & Flessa, K.W. 1998. High-resolution estimates of temporal mixing within shell beds: the evils and virtues of time-averaging. *Palaeobiology*, 24: 287-304.

- Martire, L. & Pavia, G. 1996. Taphonomic analysis of Bajocian ammonites from NW France (Normandy, Poitou). *GeoResearch Forum*, 1-2: 305-316.
- Meléndez, G.; Bello, J.; Delvene, G.; Pérez-Urresti, I. 1997. El Jurásico Medio y Superior (Calloviense-Kimmeridgiense) en el sector de la Llanura de Arcos (Ariño-Oliete, Teruel): análisis tafonómico y bioestratigrafía. *Cuadernos de Geología Ibérica*, 23: 269-300.
- Olszewski, T. 1999. Taking advantage of time-averaging. *Paleobiology*, 25: 226-238.
- Pavia, G. & Martire, L. 1997. The importance of taphonomic studies on biochronology: examples from the European Middle Jurassic. *Cuadernos de Geología Ibérica*, 23: 153-181.
- Seilacher, A. 1996. Taphonomy of Fossil-Lagerstätten. Overview. In: *Palaeobiology. A synthesis* (edited by Briggs, D.E. & Crowther, P.R.), pp. 266-270. Blackwell Science, London.
- Seilacher, A., Reif, W. E. & Westphal, F. 1985. Sedimentological, ecological and temporal patterns of fossil Lagerstätten. *Philosophical Transactions of the Royal Society of London*, 311 B: 5-23.
- Walker, K.R. & Bambach, R.K. 1971. The significance of fossil assemblages from fine-grained sediments: time-averaged communities. *Geological Society of America, Abstracts and Programs*, 3: 783-784.

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