

Remarks on the *Astarte* Bed (Upper Bajocian, Middle Jurassic) of Burton Bradstock (Dorset, Southern England)

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(With 1 figure and 4 plates)

The *Astarte obliqua* Bed of the Burton Bradstock district is subjected to detailed biostratigraphical examination. The bed is divisible by lithology and palaeontology into several horizons. However, the entire succession is not present at any of the closely spaced localities sampled, probably owing to local synsedimentary tectonics and penecontemporaneous erosion. At all the places sampled the entire bed probably belongs to the Acris Subzone of the Garantiana Zone of the Upper Bajocian. The lowest part of the bed contains an Acris Subzone ammonite fauna. With this are derived specimens, and rare well-preserved morphospecies that normally typify earlier strata ranging down to the Dichotoma Subzone. These specimens may represent an earlier age or be lingering ancestral morphs persisting into the Acris Subzone assemblage. A preliminary assessment of the taphonomic status of the fauna is also made.

Introduction

The *Astarte obliqua* Bed was first described at Vinney Cross (SY509928) east of Bridport in south Dorset, United Kingdom by HUDLESTON (1887) and later “dated” as “*Garantiana* Beds” by BUCKMAN (1910). BUCKMAN defines it as “an ironshot layer, the *Astarte* Bed, so called from the abundance of *Astarte* [now *Crassinella*] *obliqua*.” Today the only permanent exposure of the bed in the Burton Bradstock region can be seen on the coast east of West Bay and along the beach to Burton Bradstock (BB-BC), (SY468894-485890) where it can be examined in large fallen blocks. Following BUCKMAN’s (1893) account, the *Astarte* Bed here has often been cited in the literature, recently in “Addenda and Corrigenda” to CALLOMON & CHANDLER (1990), in CALLOMON & COPE (1995) and GAUTHIER et al. (2000). The *Astarte* Bed was placed in ammonite faunal horizon Bj-26b (*Parkinsonia rarecostata*), Acris Subzone, Garantiana Zone. PAVIA & MARTIRE (1997) pointed to the need to conducting a thorough taphonomic investigation of the *Astarte* Bed and claimed that the fauna listed from it in the literature represented species from a range of ages and therefore concluded that it must be condensed. These findings were used as the basis for discussion as to whether the Acris Subzone should be retained

in the Garantiana Zone (British usage) or placed in the Parkinsoni Zone of continental authors.

New cliff falls in recent years at Burton Cliff and Hive Beach, Burton Bradstock, plus excavations at the nearby Freshwater Caravan Park Quarry (BB-FCP) (SY478900), have enabled us to examine the *Astarte* Bed in fine detail at a number of places along the exposure. The description of the Burton Bradstock succession published by GAUTHIER et al. (2000) relates to a single locality on the beach and therefore differs from the composite account given here.

Conventions are standard [M], [m], macroconch and microconch, (C), (O), (R), common, occurs, rare, respectively, *TA* = Type Ammonites, BUCKMAN (1909–1930). No attempt is made to list the entire fauna. Only the ammonites of biostratigraphical significance to this work are included. Names of ammonites are used exclusively in a morphospecific sense. [M & m] are indicated as morphodimorphic subgenera enclosed in parenthesis. Within faunal horizon Bj-26a the entire assemblage of morphospecies of Parkinsonids, and likewise the Garantianas, are probably biomonospecific, with a high variability for both genera at this point in time.

Figured specimens of the R. B. CHANDLER collection are to be placed in the Sedgwick Museum, Cambridge, UK. Photographs are by the

authors. Specimens were coated with ammonium chloride prior to photography.

Burton Bradstock beach (BB–BC)

The strata of the Inferior Oolite Group are situated high in the sea cliffs above the beach and cannot therefore be examined *in situ*. However, cliff falls have produced huge blocks from which a detailed subdivision of the *Astarte* Bed has been made.

Figures 1a and 1b show a composite weathering profile section of the entire succession on the beach and 1b is that seen at BB–FCP. The *Astarte* Bed is bed 12. In any stratigraphical study of the bed and its lateral variation, it is important to understand that considerable changes occur in the succession over very short distances. The different sub-units come and go in an irregular fashion. At some locations the bed can be subdivided into two parts while at another nearby locality three distinct lithological sub-units can be identified with four horizons of fossils. It is therefore often difficult to decide from which part of the bed the ammonites come. In the past many ammonites were collected without a record of the exact location and position within the bed. Only recently did we observe that the bed is divisible and therefore we possess only limited numbers of specimens whose exact provenance is known. The rich ammonite fauna of the Burton Bradstock *Astarte* Bed has been listed previously, but not stratigraphically subdivided: see ARKELL (1933), CALLOMON & CHANDLER (1990 in ‘Addenda and Corrigenda’), CALLOMON & COPE (1995), PAVIA & MARTIRE (1997). From below:

. erosion surface, planed-off top of bed 10b ...

Bed 11: Red Conglomerate. A limonitic conglomerate with reworked fossils and small ‘snuff-boxes’. The fauna is listed by CALLOMON & COPE (1995)

0–0.03m

slightly undulating parting . .

Bed 12: *Astarte* Bed: Brown to cream, fine-grained, locally densely ironshot oolitic wackestone and packstone. Somewhat ironshot, with micrite clouds and much calcified shell material. Divisible to different extents at different points along the outcrop.

0.1–0.3 m

Bed 12a: Yellow to brown bioturbated limestone, speckled by small brown ooliths. The bed undulates and often attenuates over short distances. The base is highly ferruginous and composed mostly of broken shell debris. It contains small limonitic pebbles (3–5 mm) and rolled belemnites fragments near the base. Gastropods and small ammonites occur at all angles in the bed.

Parkinsonia (*Parkinsonia*) *rarecostata* (BUCKMAN) [m] (O)
Garantiana sp. (innermost whorls) [M]
G. longidoides group (innermost whorls) [M]
Pseudogarantiana minima (WETZEL) [m] (O)
Bajocisphinctes curvatus FERNÁNDEZ LÓPEZ non BUCKMAN [M] (R)
Spiroceras sp.

0–0.08 m

--- wavy parting, sometimes with a thin limonite skin ---

Bed 12b: Yellow oolitic limestone, the ooliths dull, medium brown and larger than below; less shelly but many intact single valves of *Astarte*. Ammonites are common and mostly lie parallel to the bedding.

Parkinsonia (*Parkinsonia*) *rarecostata* (BUCKMAN) [m]
Garantiana longidoides group [M]

0.09 m

--- wavy parting ---

Beds 12c–d: Limestone, paler, less oolitic, light brown with micrite-filled patches and abundant complete shells. Bivalves, mostly *Astarte* sp., gastropods, belemnites and brachiopods occur. The bed is undulating, but planed-off to form a very flat upper surface, which is shallow bored and coated by delicate concentric stromatolitic rings and a few large bivalves *Ctenostrum* spp. The thickness of strata preserved varies along the outcrop. In places where the bed attains greater thickness it is divisible into two horizons of fossils, many of which are beautifully preserved with mouth border or lappets. Undamaged specimens are common (Pl. 4, figs 3a, b). The upper horizon contains large perisphinctids invariably planed-across by the erosion surface. There is no lithological discontinuity between the upper and lower horizon within the bed. Bed 12d was seen at only a few localities on the beach following cliff falls, but on a number of occasions over the years.

ammonites of bed 12c:

Parkinsonia (*Parkinsonia*) *rarecostata* (BUCKMAN) [m] (C)
P. (Durotrigensia) bradstockensis DIETZE [M] (C)
Garantiana longidoides group [M] (C)
Bigotites thevenini NICOLESCO var. *densicostata* NICOLESCO [M] (O)
Vermisphinctes (Prorsisphinctes) sp. [M] (O)
Cadomites cf. *stegeus* BUCKMAN [M] (Pl. 4, figs 4a, b) (O)

0.07 m

ammonites of bed 12d:

Vermisphinctes (Prorsisphinctes) aff. *meseres* (BUCKMAN) [M] (C)
V. (Prorsisphinctes) aff. *pseudomartinsi* (SIEMIRADZKI) [M] (C)
V. (Vermisphinctes) ssp. [m] (O)
Spiroceras sp. (C)

0–0.05 m

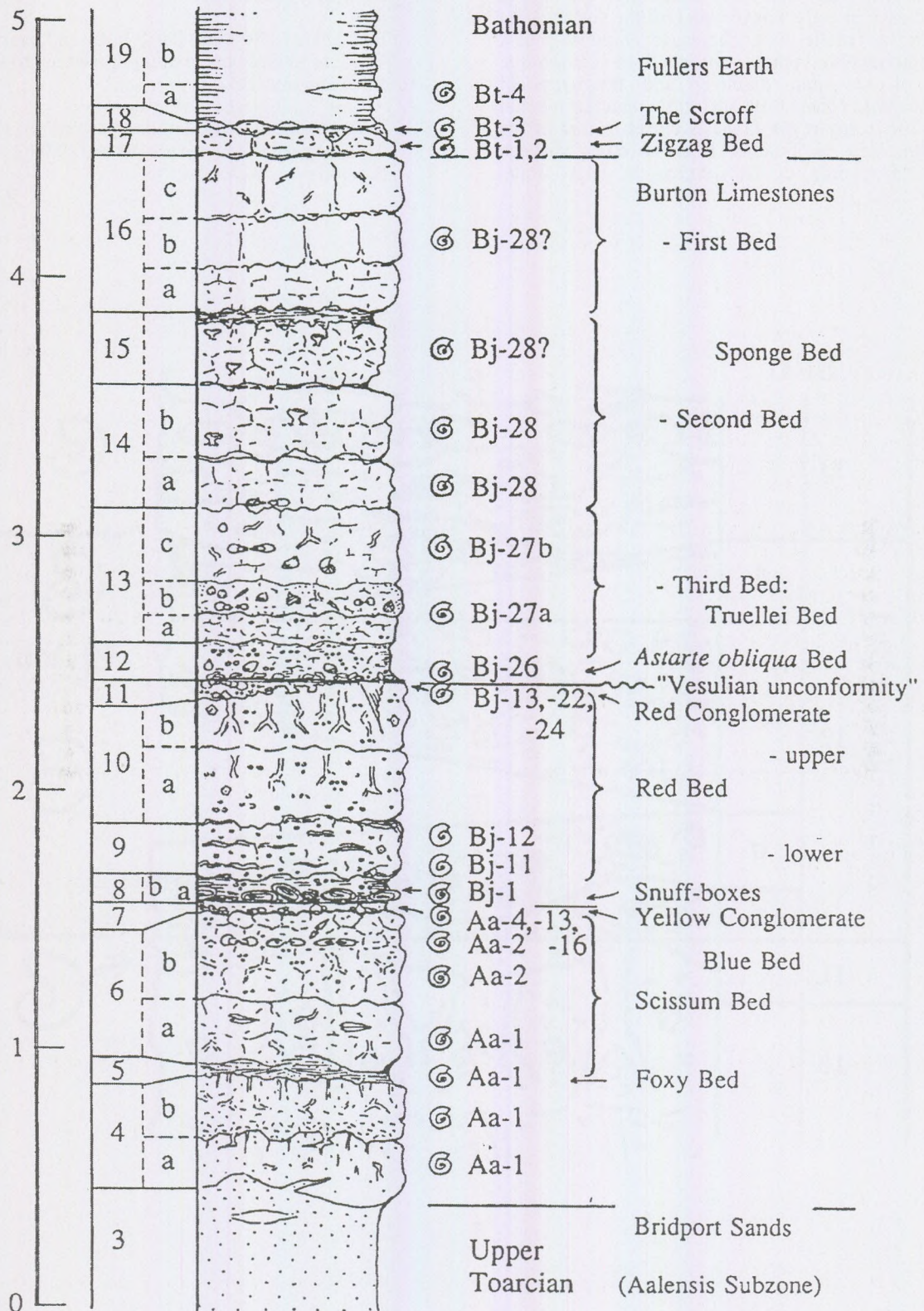


Fig. 1a. Diagrammatic section through the Inferior Oolite and basal Fullers Earth at Burton Cliff (BB-BC), Burton Bradstock after CALLOMON & COPE (1995). Note that the *Astarte* Bed (bed 12) is drawn to indicate the 'usual' thickness seen on the beach and has not been further subdivided

planned-off surface

Recently we have discovered a hard, lenticular, thin brown, irony, sparingly oolitic layer (0–0.04 m thickness) directly above the erosion surface, but below the Truellei Bed. The exact relationship of it to adjacent strata remains unclear. Two *Garantiana*, one of 110 mm diameter and fragments of *Parkinsonia* occur. With such little material it is not possible to say if the fauna is closer to that of the *Astarte* Bed or Truellei Bed, however we can confirm records of *Garantiana* in later strata,

?Truellei Subzone, both here and in Sherborne (CHANDLER et al. 1999).

Bed 13: Truellei Bed

Bed 13ai: Limestone, hard, buff, and sparingly oolitic in its lowest part grading upwards into a non oolitic cream micrite.

Parkinsonia (*Parkinsonia*) *parkinsoni* (SOWERBY) α [m] (C)

P (*Durotrigensia*) cf. *dorsetensis* (WRIGHT) [M] (C)

Garantiana longidoides group [M] (R)

0.17 m

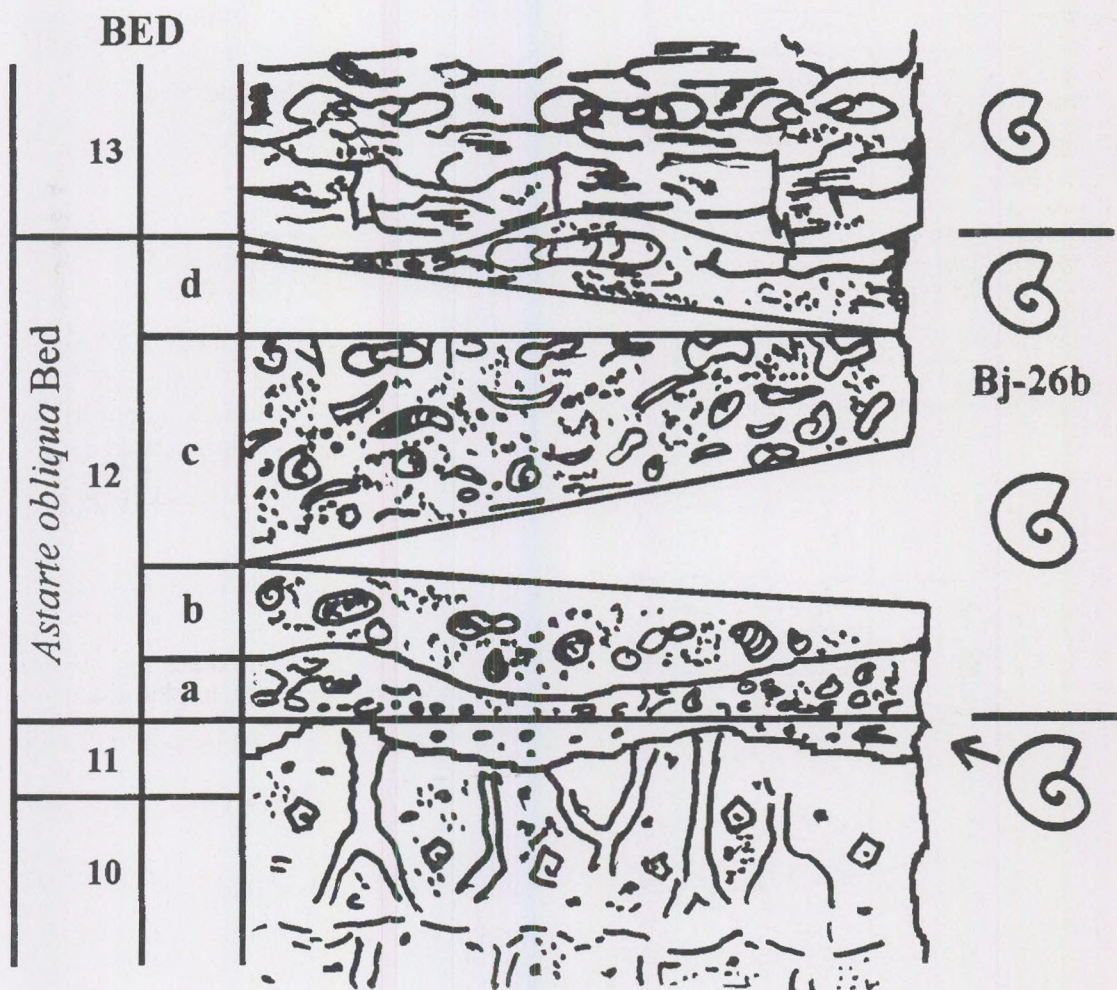


Fig. 1b. Diagrammatic section through the *Astarte obliqua* Bed (bed 12) at Freshwater Caravan Park (BB-FCP), Burton Bradstock. The composite thickness of 0.6 m is never seen in its entirety. The Red Bed (bed 10) and overlying Red Conglomerate (bed 11) persist over the entire exposure. The Truellei Bed (bed 13) is often degraded or removed. At the western end of the quarry, where part of the section was measured, bed 12d displayed an undulating upper surface forming the top of the quarry. Other rocks have been omitted.

Burton Bradstock, Freshwater Caravan Park (BB–FCP)

This important section lies just inland from the coast at Freshwater and was created by a northward enlargement of the Caravan Park. Here the overlying Parkinsoni Zone is much degraded due to its proximity to the surface. The underlying *Astarte* Bed has however provided some of the most beautifully preserved specimens available. The section recorded here was made at the western end of the quarry and describes only the *Astarte* Bed. The present exposure available for study is much thinner and lies about 30 m to the east.

Red Conglomerate

erosion surface

Bed 12: *Astarte* Bed

total 0.3–0.6 m

Bed 12a: An undulating bed of yellow stone speckled by brown ooliths. Mostly made up of broken shell debris. The ammonites are frequently small innermost whorls, mostly incomplete and damaged.

Parkinsonia (*Parkinsonia*) *rarecostata* (BUCKMAN) [m] (O)
P (*Parkinsonia*) *subarietis* WETZEL [m] (R)
P (*Durotrigensia*) *bradstockensis* DIETZE [M] (O)
Garantiana sp. [M] (indeterminable inner whorls)
Garantiana aff. *platyrryma* (BUCKMAN) [M]
 (Pl. 1, figs 2a–c; Pl. 2, figs 3a–c) (R)
G. longidoides group [M] (innermost whorls) (O)
Pseudogarantiana minima (WETZEL) [m] (O)
P aff. *minima* (WETZEL) [m] (C)
Spiroceras annulatum (DESHAYES) [?]m

0.02–0.08 m

--- wavy parting ---

Bed 12b: Yellow oolitic limestone, less shelly, but with many intact *Astarte*. The ammonites are larger than in 12a but generally smaller than those of 12c above. Many are preserved with the shell and ornament intact. The ammonite fauna of this bed is the most diverse and is listed below.

0.06–0.10 m

indistinct undulating parting

Bed 12c: The upper surface of the bed terminates in a dead-flat, bored erosion surface. Near the top, limestone, paler, less oolitic with large *Garantiana* of the *longidoides* group (diameter 90–130 mm), sometimes extremely involute (*G. longidens* BUCKMAN non QUENSTEDT, now *G. longidoides* [GAUTHIER et al.]). These co-dominate with complete, but disarticulated valves of *Astarte* and belemnites. Parkinsonids, perisphinctids and other elements identical with the fauna of the lower part of bed 12c occur only

rarely. In the lowermost 20 cm is a layer of large perisphinctids. Here the fauna of bed 12b continues, but is more common and of larger size. The ammonites are now often beautifully preserved with mouth border or lappets with common undamaged specimens. The following list includes the ammonites found in both 12b & c. The fauna of each level is identical, however there is a shift in the relative abundance of individual species.

Parkinsonia (*Parkinsonia*) *rarecostata* (BUCKMAN) [m]
 (Pl. 1, figs 1a, b; Pl. 4, figs 2a, b) (C)
P (*Parkinsonia*) *pseudoparkinsoni* WETZEL [m]
 (Pl. 2, figs 2a, b) (O)
P (*Durotrigensia*) *bradstockensis* DIETZE [M] (O)
P (*Durotrigensia*) aff. *dorsetensis* (WRIGHT) [M]
 (Pl. 1, figs 3a, b; Pl. 2, figs 1a, b) (O)
Garantiana longidoides group [M]
 (Pl. 3, figs 1a, b; figs 2a–c; figs 3a, b) (O)
Vermisphinctes (*Prorsisphinctes*) *meseres* (BUCKMAN) [M] (C)
V (*Prorsisphinctes*) cf. *meseres* (BUCKMAN) [M] (C)
V (*Vermisphinctes*) ssp. [m] (O)
Bigotites ssp. [m & M] (O)
Oxycerites flexus (BUCKMAN) [M] (O)
Oxycerites cf. *subradiatus* (WAAGEN) [M] (C)
Oecotraustes ssp. [m] (O)
Lissoceras ssp. [M] (O)
Microliissoceras sp. [m] (R)
Cadomites arkelli STURANI [M] (R)
Cadomites cf. *stegeus* BUCKMAN [M] (O)
Strigites septecarinatus BUCKMAN [M] (R)
Strigoceras aff. *truellei* (D'ORBIGNY) (R)
Cadomoceras sp. [m] (R)
Sphaeroceras tutthum (BUCKMAN) [?]m (R)
Sphaeroceras tenuicostatum STURANI [?]m (R)
Spiroceras cf. *annulatum* (DESHAYES) [?]m (O)

0.15–0.28 m

--- erosion plane and thin limonitic crust ---

Bed 12d: Oolitic limestone that contains exclusively large (200–300 mm) and very common macroconch parkinsonids, showing variability between *P. (Durotrigensia)* aff. *dorsetensis* (Pl. 1, figs 3 a–b; Pl. 2, fig. 3a, b) and *P. (Durotrigensia)* *bradstockensis*. These macroconchs occur infrequently in bed 12b, however *P. (Durotrigensia)* *bradstockensis* is already present, but rare in bed 12a. The exact relationship of bed 12d at BB–FCP to 12d at BB–BC is not precisely known. These beds although in the same relative position may represent horizons of slightly different age.

Parkinsonia (*Durotrigensia*) *bradstockensis* DIETZE [M]
P (*Durotrigensia*) aff. *dorsetensis* (WRIGHT) [M]

0.1–0.14 m

---indistinct parting or top soil at some points in the quarry---

Biostratigraphy and description of some elements of the ammonite fauna

CALLOMON & COPE (1995) and CALLOMON (1995) include the *Astarte* Bed of Burton Bradstock in their ammonite faunal horizon Bj-26b (*Parkinsonia rarecostata*) of the Acris Subzone. PAVIA & MARTIRE (1997) were of the view that the *Astarte* Bed of Dorset contained ammonites that occur elsewhere in three subzones (Garantiana, Tetragona and Acris Subzone) and that a taphonomic investigation would conclude that the bed contained a condensed assemblage.

It has long been the practice of British workers (e.g. TORRENS 1969) to include the Acris Subzone in the Garantiana Zone, at variance with continental authors' placement of it in the succeeding Parkinsoni Zone (i.e. GAUTHIER et al. 2000). The criteria for this decision are summarised by PARSONS (1976). The Burton Bradstock *Astarte* Bed has no bearing on this matter as the type area of the Garantiana Zone is exclusively the Sherborne area, not South Dorset (BUCKMAN 1893). Moreover the *Astarte* Bed of Southern England as a lithostratigraphical unit is diachronous. Its probable age range is the Dichotoma Subzone of the Garantiana Zone (Louse Hill, CALLOMON & COPE 1995) up to the Acris Subzone (Burton Bradstock, Loders Cross) but at some places possibly slightly later.

The lowest part of the *Astarte* Bed of Burton Bradstock contains small, but adult and nearly complete specimens of *Garantiana* aff. *platyrryma* (Pl. 1, figs 2a–c; Pl. 2, figs 3a–c) from bed 12a of FCP. These rare, but well-preserved specimens probably represent the extreme variant (small size) of an assemblage that is close to being isochronous. This characteristic species occurs elsewhere consistently earlier than the Acris Subzone. Its type area and horizon is the *Astarte* Bed of Louse Hill (near Sherborne, Southern England), dated as Dichotoma Subzone by CALLOMON & COPE (1995). At Louse Hill the *Astarte* Bed yields small *Leptosphinctes* (*Cleistosphinctes*) spp. that differ in their small size from the large specimens typical of the Acris Subzone. In the Acris Subzone such microconchs are usually labelled as *Vermisphinctes* spp. *Pseudogarantiana dichotoma* is very abundant at Louse Hill in marked contrast to its absence in bed 12a at Burton Bradstock. The *Astarte* Bed of Louse Hill is very thin (0.01–0.3 m) and highly variable. At the eastern end of the quarry it can be subdivided into two with a lower part containing ammonites of the Niortense Zone (*Caumontisphinctes* sp. VD & RBC coll.). GAUTHIER et al. (1997) and RIOULT et al. (1997) report French specimens of *Garantiana platyrryma* in the Dichotoma Subzone equivalent to those indicated by FERNÁNDEZ-LÓPEZ (1985) from the Spanish Cordillera Ibérica (Biohorizonte Tenuicostatus = Dichotoma Subzone). It is unusual that this morphospecies ranges in the Burton Bradstock *Astarte* Bed more than two subzones higher than found so far anywhere else in Europe, however specimens with features of the ancestral morphology may persist into later strata. We conclude that Bed 12a is entirely Acris Subzone, although it is possible that it contains derived fossils in addition, with an age range from at least Dichotoma Subzone to Acris Subzone age. We do not have adequate material to show conclusively that *G.* aff. *platyrryma* are extreme variants of the

Garantiana longidoides assemblage of horizon Bj-26b or not. We observe that the morphological differences seen in these rare ammonites compared with the rich *longidoides*-assemblage is significant and may therefore be of a slightly earlier age. They are of much smaller size and lack the typical prominent ventral spines at the end of the ribs. These specimens show the same excellent state of preservation as the accompanying typical elements of the Acris Subzone. They are nearly complete and lack evidence of reworking. From a collection numbering hundreds of specimens from the *Astarte* Bed of Burton Bradstock we were unable to find any further characteristic Dichotoma Subzone faunal elements. A typical ammonite fauna for bed 12a includes *P.* (*Parkinsonia*) *rarecostata*, *P.* (*Durotrigensia*) *bradstockensis* and *Garantiana* of the *longidoides* group in association with derived elements. The ammonites of bed 12a are often incomplete and small, large ammonites occur only rarely. The matrix of the bed shows a mixture of different lithologies and evidence of bioturbation.

We have not recorded ammonites of the *G. garantiana* group or *G. tetragona* in the *Astarte* Bed. The specimen published by BUCKMAN (1922) as *G. garantiana* (TA, pl. 358) certainly belongs to another species, probably of the *Garantiana longidoides* group. Some ammonites of the *Garantiana longidoides* group from the Burton Bradstock *Astarte* Bed show a great resemblance to those of the *G. garantiana/subgaranti* group, however the ventral aspect and style of ribbing differ in a characteristic way. We cannot agree with PAVIA & MARTIRE (1997) that *G. longidens* BUCKMAN non QUENSTEDT (= *G. longidoides* [GAUTHIER et al.]) of the Acris Subzone), *Pseudogarantiana minima* (range Garantiana Subzone to Acris Subzone), *Prorsisphinctes meseres* and *P. stomphus* (both occur in the Acris Subzone) are typical of the Tetragona Subzone. The occurrence of *Bajocisphinctes curvatus* FERNÁNDEZ-LÓPEZ non BUCKMAN in bed 12a of the beach and *ex-situ* specimens from FCP may be a hint of the existence of the Garantiana or Tetragona Subzone in the lowermost part of the Burton Bradstock *Astarte* bed, but we have no firm evidence for this.

Parkinsonia (*Parkinsonia*) *rarecostata* (type horizon and area, Burton Bradstock *Astarte* Bed) and the last representatives of the genus *Garantiana* are typical elements of the Acris Subzone. Both occur in the Burton Bradstock *Astarte* bed from bed 12a up to bed 12c. It is of interest that *P.* (*P.*) *rarecostata* exhibits two variants, one with a rather rounded venter and whorl section, the other with a more rectangular whorl section (Pl. 1, figs 1a, b). A typical additional element of the Acris Subzone is *P.* (*Durotrigensia*) *bradstockensis* [M] which is the macroconch counterpart *P.* (*Parkinsonia*) *rarecostata* [m]. The *G. longidoides* group is characterised by thin, long spines that follow the direction of the ribs and emerge from the point of bifurcation. The morphological variability of *Garantiana* in the Burton Bradstock *Astarte* Bed has not so far been described but it appears that all variants are members of one clearly characterised group, differing slightly from WETZEL's syntypes of *G. alticosta* from Bielefeld (Northern Germany) and also from the *G. alticosta* group DIETZE non

WETZEL, described from the Eastern Swabian Alb (DIETZE 2000).

Of interest are specimens of parkinsonids in beds 12b, 12c and 12d (FCP) which stand apart from typical members of the *Parkinsonia rarecostata* group. The whorls are more rounded and show a more involute character. Lacking a more precise specific name, we have labelled the macroconchs as *P. (Durotrigensia) aff. dorsetensis* (Pl. 1, figs 3a, b; Pl. 2, figs 1a, b). The microconchs are morphologically identical to *P. (Parkinsonia) pseudoparkinsoni* (Pl. 2, figs 2a, b). The latter species was described by GABILLY et al. (1971) from Saint-Maixent (Western France) from a slightly higher horizon than that with typical ammonites of the *P. rarecostata* group, but still in the "Subarictis" Subzone (=Acris Subzone). BUCKMAN (1910) pointed out that in the *Astarte* Bed of Burton Bradstock forms intermediate between *P. rarecostata* and *P. parkinsoni* occur.

We conclude that beds 12b and c, both on the beach and at BB–FCP contain an association belonging to the Acris Subzone. The stratigraphically important faunal elements, *Garantiana* and *Parkinsonia* show no discernible evolutionary change within these beds, thus they belong to the same faunal horizon. We can make no further subdivision although the different species occur with different frequency in each level. Beds 12 b–c represent faunal horizon Bj–26b of CALLOMON & COPE (1995), while bed 12 a (BB–BC and BB–FCP) may contain some derived specimens. Faunal horizon Bj–26b can be subdivided in Western France perhaps into two. In Northern and Southern Germany (DIETZE 2000), Normandy (GAUTHIER et al. 1997) and in the Sherborne area of Southern England (CHANDLER et al. 1999) occur other faunal horizons, but also in the Acris Subzone.

Bed 12d (FCP) seems to contain a local accumulation of macrococh parkinsonids, which have not been found elsewhere and still belong in faunal horizon Bj–26b. They are more frequent than below, but do not differ in their specific composition.

Bed 12d (BB–BC) has only been observed just east of Freshwater. It probably represents a slight

upward extension of the strata exposed at FCP where it has been planed-off. It contains large, smooth *Vermisphinctes (Prorsisphinctes) aff. meseres* together with *V. (Vermisphinctes) spp. [m]*. Most are cut through by the erosion surface. The same ammonites are prolific in the uppermost part of the *Astarte* Bed at Loders Cross, close to Vinney [=Vetney] Cross, east of Bridport. Another section was described at Stoney Head (SY496927) by PARSONS (1975). There only about 1 km west of Loders Cross it appears to have the *Vermisphinctes* bed missing, as the characteristic fauna was not recorded by PARSONS (1975). The section at Loders Cross has been recorded by CHANDLER (unpublished) and PAGE (unpublished). Both these workers independently observed the *Astarte* Bed was divisible into three parts. From below:

a) Grey to yellow, pyritic limestone with small dark brown oolites. The most common ammonites are of the *Garantiana garantiana/subgaranti* group, typical elements of the *Garantiana* Subzone elsewhere. Ammonites of the genus *Parkinsonia* were not found at this level.

b) A thin marly, intraclastic band and

c) Cream limestone, micritic and scattered by clouds of pale brown oolites. Large (up to 400 mm) *Vermisphinctes (Prorsisphinctes)* of the *meseres* group [M] are the dominant fossil (a more specific investigation is beyond the scope of this work). At the top of this bed is a rather variable, partly rotted shell bed with abundant gastropods, belemnites, *Spiroceras*, *Garantiana* and rare *Parkinsonia rarecostata*, thus probably still Acris Subzone.

d) This bed is overlain by a layer of poorly preserved *Parkinsonia* of the *parkinsoni* group presumably equivalent to the base of the Truellei Bed on the coast.

Parkinsonia is very rare in the *Vermisphinctes* bed. The influx of large perisphinctids and scarcity of parkinsonids is evidence of some marked ecological change at the time.

Taphonomy

An interpretation of the taphonomic status of the *Astarte* Bed fauna at Burton Bradstock will serve to increase the reliability of the biostratigraphy. FERNÁNDEZ-LÓPEZ (1991) defines three categories of post-mortem remains found in the fossil record: accumulated, re-sedimented and reworked elements. Each category can be identified in the succession at Burton Bradstock, however care must be exercised in the interpretation of old collections as they have not been collected by subdivision of the bed in the way described here. A thin succession of strata deposited over an extended time period is generally accepted to indicate homogeneous condensation as defined by CALLOMON (1985). The Inferior Oolite, including the *Astarte* Bed, displays a particular type of condensation, in which individual beds, probably deposited in a brief interval are separated by surfaces representing gaps of unknown duration.

The *Astarte* Bed is divisible by discrimination of the ammonite fauna and by taphonomy. Bed 12a contains reworked fossils that display abraded surfaces, infill that differs from the host matrix and encrustation. A conglomerate is present at the base which contains small limonite oncolites, some surrounding ammonite fragments. Rounded fragments of broken shell occur and show evidence of sponge boring and biological attack. Contemporary, well-preserved material also occurs. Bed 12b and c in contrast show evidence of containing fossils of a very narrow age range (Acris Subzone). 12d (BB–BC) at present known only locally is also probably still Acris Subzone but characterised by a horizon of perisphinctids which do not occur abundantly below. Tens of specimens collected from each level are very well preserved, lack significant epifaunal colonization and possess intact thin mouth borders and lappets. Ammonites

are frequently perfect and ornamented by thin, long spines such as the *Cadomites* cf. *stegeus* figured here (Pl. 4, figs 3a, b). Sexual dimorphs of characteristic species consistently occur together in the same faunal horizon at different localities. It is difficult to accept that such material can have suffered anything but a minimal pre-burial history. Some horizons do contain large quantities of broken material (re-sedimented bio-clasts), but these fragments are invariably cleanly broken with sharp edges and little abrasion evidence. The mode of preservation within each horizon is identical, but may differ between horizons. Both the colour and nature of the calcite are the same in the fragmentary and complete material within each horizon. Some horizons may well represent the accumulation of some debris from slightly different levels, possibly

as a result of storm activity or bioturbation, however the possible range of ages incorporated in such levels is insignificant in geological terms. The composition of species recorded from individual faunal horizons is remarkably consistent across large geographical areas. In places where the succession is expanded (i.e. north Dorset) the same faunal composition has been recorded as that from thin individual beds on the coast. At some localities different horizons appear that are not well represented on the coast. A characteristic layer of (*Prorsisphinctes*) *Vermisphinctes* of the *meseres* group (Pl.4, figs 1a, b) occurs perfectly preserved in the upper part of the *Astarte* Bed at Loders Cross while on the beach the same is indicated by planed-through examples at the top of the bed.

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Plates

Plate captions

The last preserved septum of each specimen is indicated on the plates by a black dot. In cases where the preservation of the shell is perfect the indicated position of the last suture is approximate.

Plate 1

All specimens are from the Acris Subzone, faunal horizon Bj-26b

- Figs 1a, b. *Parkinsonia* (*Parkinsonia*) *rarecostata* (BUCKMAN) [m] (coll. DIETZE), complete with mouth border from BB-FCP, bed 12c, (x 1), large variant.
- Figs 2a-c. *Garantiana* aff. *platyrryma* (BUCKMAN) [M] (Sedgwick Museum X28016), nearly identical to the holotype from the *Astarte* Bed of Louse Hill, BB-FCP, bed 12a (x 1).
- Figs 3a, b. *Parkinsonia* (*Durotrigensia*) aff. *dorsetensis* (WRIGHT) [M] (coll. DIETZE, collected by D. SOLE) fully septate phragmocone showing the innermost whorls, from BB-FCP, bed 12b, (x ½).



Plate 2

All specimens are from the Acris Subzone, faunal horizon Bj-26b

- Figs 1a, b. *Parkinsonia* (*Durotrigensia*) aff. *dorsetensis* (WRIGHT) [M] (Sedgwick Museum X29053, collected by D. SOLE), nearly complete specimen from BB-FCP, bed 12c (x 1/3).
- Figs 2a, b. *Parkinsonia* (*Parkinsonia*) *pseudoparkinsoni* WETZEL [m] (coll. DIETZE). Phragmocone from BB-FCP, bed 12c (x 1), large variant.
- Figs 3 a-c. *Garantiana* aff. *platyrryma* (BUCKMAN) [M] (coll. DIETZE) with slightly more radiate ribbing than Pl. 1, figs 2 a-c, from BB-FCP, bed 12a, most probably Dichotoma Subzone (x 1).

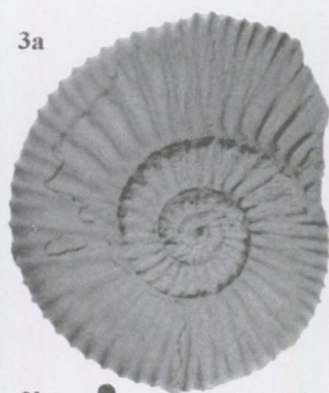


Plate 3

All specimens are from the Acris Subzone, faunal horizon Bj-26b

- Figs 1a, b. *Garantiana longidoides* (GAUTHIER, TRÉVISAN & JORON) [M] (Sedgwick Museum X28013), large, complete example from BB-BC, bed 12c, (x 1).
- Figs 2a-c. *Garantiana longidoides* (GAUTHIER, TRÉVISAN & JORON) [M] (coll. DIETZE, collected by D. SOLE), evolute variety with slim whorls from BB-FCP, bed 12c, (x 1).
- Figs 3a, b. *Garantiana longidoides* (GAUTHIER, TRÉVISAN & JORON) [M] (coll. DIETZE), typical morph from BB-FCP, bed 12b, (x 1).

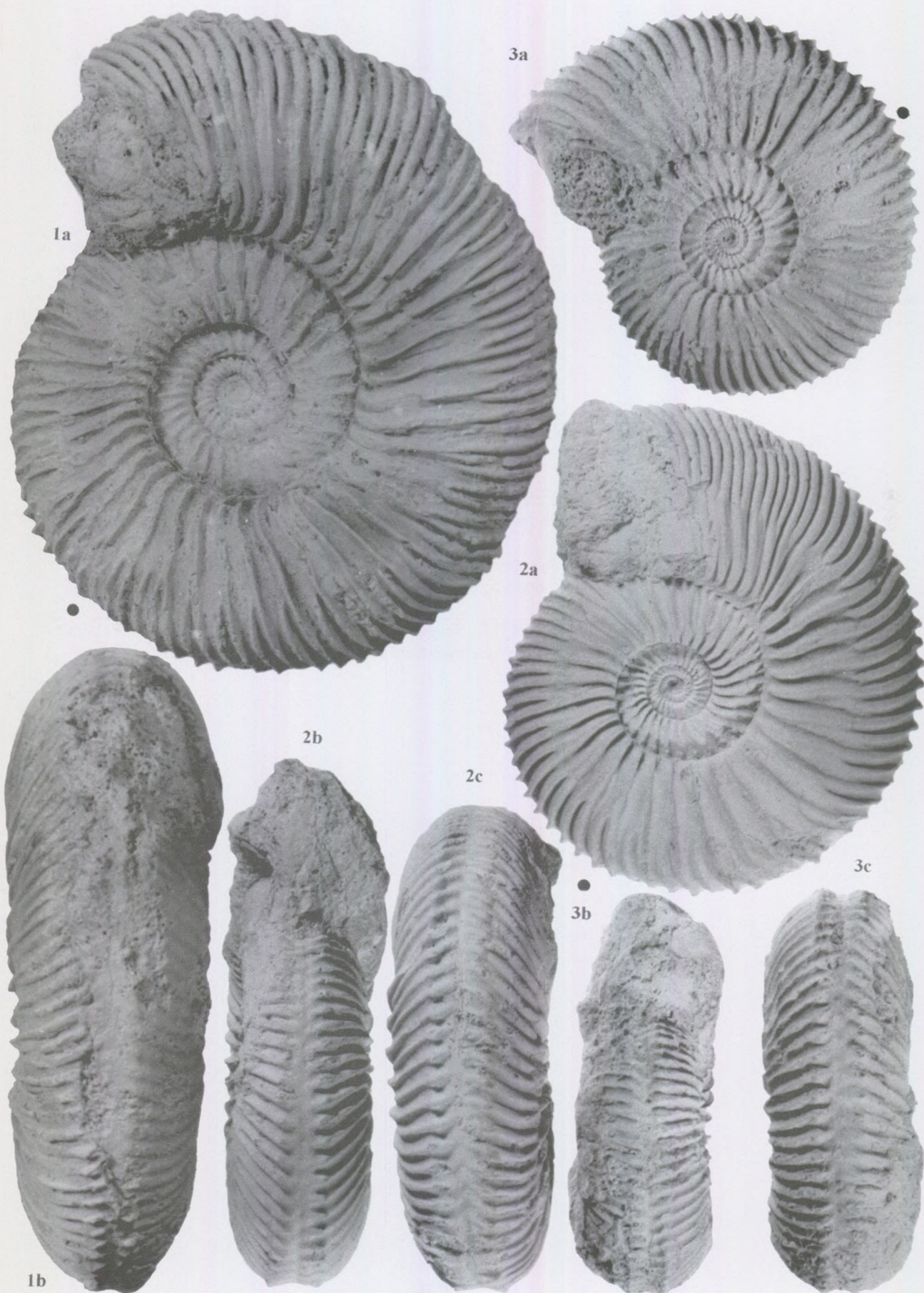


Plate 4

All specimens are from the Acris Subzone, faunal horizon Bj-26b

- Figs 1a, b. *Vermisphinctes (Prorsisphinctes) aff. meseres* (BUCKMAN)[M] (Sedgwick Museum X28011) perfectly preserved specimen from the *Vermisphinctes* bed, Loders Cross near Bridport, (x ½).
- Figs 2a, b. *Parkinsonia (Parkinsonia) rarecostata* (BUCKMAN) [m] (Sedgwick Museum X28015), phragmocone from BB-BC, bed 12c, Bj-26b, (x 1).
- Figs 3a, b. *Cadomites cf. stegeus* BUCKMAN [M] (Sedgwick Museum X28017, collected by H. PRUDDEN), perfectly preserved and complete specimen from BB-BC, 12c, (x 1).



