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On the Ammonites of the Speeton Clay and the Subdivisions of the Neocomian.

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CONTENTS.

I.

IN some recent papers dealing with Tithonian ammonites, the writer[1] included zonal schemes of the higher Jurassic, up to what he considered the topmost horizon, namely the *privasensis* zone. The correlation of the Mediterranean ammonites with those of the "boreal province" or Pavlow's "Aquilonian" was also discussed. Since this author[2] had recorded "Aquilonian" *Craspedites* and *Garniericeras* from the Speeton Clay and Spilsby Sandstone, the inquiry naturally led to a revision of the ammonites of the Neocomian of Yorkshire and Lincolnshire. A critical examination of the ammonite horizons at the Jurasso-Cretaceous border-line seemed specially invited because in our most recent textbooks Yorkshire strata obviously well up in the Cretaceous are still included in the Jurassic; and it was also deemed useful to link up the table of Tithonian ammonite zones, above referred to, with that of the Aptian, given by the writer in a paper on the "Ammonite Horizons of the Gault and Contiguous Formations".[3]

By the courtesy of the authorities of many Public Museums and numerous private collectors, to all of whom grateful acknowledgements are here tendered, I have been able to examine a great number of ammonites of the Speeton Clay and of the Lower Cretaceous formations of Lincolnshire and Norfolk. With the aid of a grant from the Royal Society, I was also enabled to inspect the cliff-section at Speeton, and though the primary object of my visit, namely the uppermost beds, with the Gault, were very poorly exposed last year, the visit greatly increased my admiration for the zeal and labour embodied in the accounts and collections of my predecessors. The modern refinement in stratigraphical and palæontological nomenclature, and the additional knowledge of the last thirty years, necessitated a revision of the Speeton sequence; but this revision would have been impossible without the study of the splendid

[1] "Jurassic Ammonites from New Zealand": *Q.J.G.S.*, vol. lxxix, 1923. "On the Blake Collection of Ammonites from Kachh, India" *Mem. Geol. Surv. India, Pal. Indica*, 1923.

[2] In Pavlow and Lamplugh, *Argiles de Speeton*, Moscou, 1892. pp. 116, 117 (*Craspedites subditus* and *C. fragilis*). Pavlow, *Etudes sur les Couches Jurass. et Crét. de la Russie*, i, Moscou, 1889, pl. iv, figs. 6–8 (*Craspedites* cf. *subditus* and *Oxynoticeras catenulatum*).

[3] "Summary of Progress for 1922" *Geol. Surv.*, 1923, Appendix ii.

collections accumulated by Mr. C. G. Danford and Mr. G. W. Lamplugh, F.R.S. To the latter I am particularly indebted for continuously placing at my disposal his unrivalled knowledge of the succession, and, in the course of many discussions, both before and after my visit to Speeton, criticizing my views. The section, unfortunately, still represents the " huge mess ", so vividly described by Mr. Sheppard,[1] though, with sufficient patience, all the beds can be examined " in place ", on the hand of Mr. Lamplugh's excellent accounts.[2] If I follow Professor Judd [3] in pinning my faith to ammonites, not belemnites, it may be explained as the natural prejudice of a specialist. There may be a very marked change in the belemnite fauna at all the sectional boundaries, as Mr. Danford [4] stated, but even Stolley's [5] minute researches on the North German belemnite successions did not enable him to zone the Aptian of that country. For from an examination of my table of Aptian zones [6] it will be seen that the fauna of e.g. Ahaus is later than the *deshayesi* horizon (subzone of *Cheloniceras hambrovi* in Spath, p. 147) and earlier than the fauna with *Parahoplites schmidti* and *Sanmartinoceras* [7] *trautscholdi* (*aschiltaensis* subzone of my table). Nor did Stolley discover the absence, in North Germany, of probably the whole of the Lower and the lower part of the Upper Gault.

The lists of ammonites below, like the correlation table that follows, speak for themselves to those acquainted with ammonites and the classical Lower Cretaceous successions; but it may be advisable to summarize the more important points brought out in them for the general reader. It ought also to be mentioned that since the important successions of e.g. the South of France have not been zoned in sufficient detail, and since the identification of the French ammonites is too inaccurate for exact correlation, the table here given cannot be considered to be more than provisional. The palæontological notes at the end contain a revision of the ammonite nomenclature, notably of the Crioceratids.

II.

In the following lists of ammonites, those from Speeton are given in ascending order, i.e. from the lowest ammonitiferous bed

[1] " Notes on Some Speeton Clay Belemnites ": *Hull Mus. Public.*, No. 29, March. 1906, p. 1.

[2] " On the Subdivisions of the Speeton Clay " *Q.J.G.S.*, vol. xlv, 1889, pp. 575–618. " On the Speeton Series in Yorks. and Lincs.": ib., vol. lii, 1896, pp. 179–220.

[3] " On the Speeton Clay ": *Q.J.G.S.*, vol. xxiv, 1868, pp. 218–50.

[4] " Notes on the Belemnites of the Speeton Clay ": *Trans. Hull Geol. Soc.*, vol. v, 1906, pt. i, p. 2.

[5] " Glied. d. Nordd. Unt. Kreide ": *Centralbl. f. Min.*, 1908, pp. 107 ff.

[6] Loc. cit., Summ. Progr. 1922, table on p. 147

[7] *A. fontinalis*, Hudleston: Geol. Mag., 1890, p. 241, pl. ix, fig. 1, B.M. C. 5306, belongs to this keeled and costate Desmoceratid stock, quite distinct from the earlier *Aconeceras* Hyatt.

D_4 up to the top of B. The few Gault specimens known from Speeton are referred to in a later chapter (IV).

SPEETON.

D_4. (Near base.) *Polyptychites* aff. *lamplughi* Pavlow.

D_4. (Middle.) *Polyptychites* sp.n.? (aff. *beani* Danford,[1] xi, 4).

D_4. *Polyptychites* cf. *keyserlingi* (Neumayr & Uhlig) Pavlow (1892, v, 13). *P.* (*Dichotomites* ?) sp.n. ? ("*Craspedites fragilis*" Pavlow non Trautsch. sp.). *P.* (*D* ?) sp.n. ? ("*Craspedites fragilis*" Danford, xi, 1). *P.* (*D* ?) sp. ind. aff. id. *P.* (*D* ?) sp. juv.

D_{3-4}. *Polyptychites* aff. *michalskii* Bogoslowsky. *P.* aff. *rectangulatus* Bog. *P.* sp. ind.

D_3. *Polyptychites polyptychus* (Keys.) Bogosl. *P.* cf. *polyptychus* (Keys.) Bogosl. *P. cavaticus* (Bean MS.). *P. ramulicosta* Pavlow. *P. ramulicosta* Bogosl. non Pavl. *P.* (*Valanginites* ?) sp.n. (astieriform). *P.* (*Val.*?) aff. do. *P.* **pyritosus** sp.n. ("*lamplughi*," Pavlow, pars, viii, 1). *P.* cf. *michalskii* Bogosl. var. (xv, 6).[2] *P.* cf. *gravesiformis* Pavlow. *P.* aff. *subrectangulatus* Bogosl. ("aff. *beani*" in Danford, xi, 2). *P.* spp. juv. ind. *P.* (*Dichotomites*) sp.n. ? ("*fragilis*" Pavlow). *P.* (*D.*) sp.n. ? ("*fragilis*" Danford). *P.* (*D.*) spp. ind.

D_3. (Top.) *Polyptychites* cf. *keyserlingi* (Pavl. non Neum. & Uhlig).

D_{2-3}. *Polyptychites* cf. *michalskii* var. Bogosl. *P.* cf. *polyptychus* (Keys.) Bogosl.

D_2. (Base.) *Lyticoceras* aff. *planicosta* v. Koenen sp. *Olcostephanus* ("*Astieria*") sp. cf. *convolutus* Uhlig non v. Koenen.[3] *O.* (**Rogersites** ? [4]) cf. *convolutus* v. Koenen. *Polyptychites subgravesi* sp.n. (= "*keyserlingi*" Pavlow, ix, 1). *P.* cf. *sphæricus* v. Koenen (gigantic). *P. ramulicosta* Pavlow. *P.* aff. *polyptychus* (Keyserl.) Pavlow. *P.* **sublatissimus** sp.n. (= cf. "*keyserlingi*" Danford, x, 3). *P.* sp.n. (between *gravesiformis* Pavl. and *sublatissimus* nov.). *P.* (*Dichotomites* ?) spp. juv. ind. *Dichotomites beani* Pavlow. *D.* aff. *beani* Pavlow. *D.* sp.n. ? ("*beani*" Danford, xi, 5). *D.* **typicus** sp.n. (= "*polyptychus*" Danford, x, 2). *D.* aff. *grotriani* (Neum. & Uhlig). *Neocraspedites* [5] **speetonensis** n. (= "*bidichotomus*" Danford, x, 1).

D_2. *Hoplitides* aff. *submartini* Sayn (= "*heteroptychus*" Danford, xiv, 2). *H. heteroptychus* (Pavlow). *Lyticoceras* aff. *oxygonium* (Neum. & Uhlig). *L.* cf. *noricum* (Schloth.). *L.* **danfordi** sp.n. (Danford, xiii, 6). *L.* sp. ind., *noricus*-gp. (Danford, xiii, 5). *Distoloceras* **pavlowi** sp. nov. (= "*hystrix*" (Phill.) Pavlow, x, 10). *D.* cf. *spinosissimum* (Haussmann). *D.* cf. *roemeri* (Neum. & Uhlig). *D.* aff. *longinodum* (Neum. & Uhlig). *D. curvinodum* (Phill.). *Bochianites neocomiensis* (D'Orb.). *Polyptychites* cf. *multiplicatus* (Roem.) v. Koenen (iii, 4).[6] *P. sphæricus* v. Koenen. *P.* aff. *gravesiformis* Pavlow. *P.* **euryptychoides** sp.n. (sp. ind. E., Bogosl., xvi, 6). *P.* aff. *subgravesi* nov. *P.* sp. ind. *Dichotomites* aff. *beani* (Pavlow). *D. bidichotomus* (Leym.) Neum. & Uhlig sp. *D. bidichotomus* (Leym.) Pavlow sp. *D.* aff. id. *D.* sp.n. ? aff. "*Craspedites*" *fissuratus* v. Koenen.

[1] "Notes on the Speeton Ammonites": *Proc. Yorks Geol. Soc.* (N.S.), vol. xvi, 1906.

[2] "Mat. z. Kenntn. d. Untercret. Amm. Fauna, etc.": *Mém. Com. Géol. St. Petersb.* (N.S.), Livr. ii, 1902, p. 135.

[3] "Fauna of the Spiti Shales": *Mem. Geol. Surv. India, Pal. Indica*, ser. xv, Himalayan Foss., vol. iv, fasc. 2, 1910, pl. lxxviii.

[4] Gen. nov. (genotype: *R. modderensis* Kitchin sp.). See Pal. Notes below.

[5] Proposed (in "Ammon. Blake Coll. Kachh, India": loc. cit., 1923) for the *Craspedites*-like developments of *Dichotomites*. (Genotype: *N. semilævis* v. Koenen sp.).

[6] "Ammonitiden d. Nordd. Neocom.": *Abh. k. Preuss. Geol. L.A.*, N.F., Heft 24, 1902.

D. spp. ind. *Neocraspedites* aff. *semilævis* (Koenen). *N.* aff. *grotriani* (Neum. & Uhlig) Weerth sp. *N.* sp. nov. (? "*Craspedites*" *tenuis* v. Koenen).

D_1. *Hoplitides heteroptychus* (Pavlow). *H.* aff. *heteroptychus* (Pavlow). *Kilianella* ? **pexiptychoides** sp.n. ("*roubaudi*" Danford, xiii, 1). *K.* aff. id. ("*roubaudi*" Pavlow, pars.). *K.* cf. *leptosoma* (Uhlig). *Lyticoceras oxygonium* (Neum. & Uhlig). *L.* sp.n. ? aff. id. *L.* **stolleyi** sp.n. ("*neocomiensis* ?" v. Koenen, xxxi, 2, non D'Orb.). *L.* cf. *montanum* (Uhlig). *Leopoldia* ? sp. ind. *Distoloceras hystrix* (Phill.). *D. pavlowi* nov.

C_{11}. *Acanthodiscus* sp. ind. (*hookeri* group). *A. furcillatus* (Bean MS.). *A.* cf. *euthymi* (Pavlow non Pictet). *A.* sp. nov. ? *Lyticoceras* aff. *regale* (Bean MS.) Pavlow sp.

$C_{10\text{-}11}$. *Acanthodiscus* sp. ("*euthymi*" Danford, xiii, 8). *A. ebergensis* (Weerth). *A. bivirgatus* (Weerth). *Lyticoceras* aff. *regale* (Bean MS.) Pavlow sp.

C_{10}. *Lyticoceras regale* (Bean MS.) Pavl. sp. var. ("*oxygonius*" Danford, xiii, 3).

C_9. *Acanthodiscus ebergensis* (Weerth). *A.* aff. *ebergensis* (Weerth). *A.* aff. *bivirgatus* (Weerth). *A.* **confusus** sp.n. ("cf. *oxygonius*" Weerth, v, 4).[1] *A. munitus* (Bean MS.). *A.* sp.n. ? aff. id. *A.* aff. *furcillatus* (Bean MS.). *Lyticoceras regale* (Bean MS.) Pavlow sp. with var. *oxygonius* (Pavlow non Neum. & Uhlig) and var. *amblygonius* (Pavlow non Neum. & Uhlig). *Barremites* **subcassida** sp.nov. (="cf. *cassidoides*" Pavlow, xi, 19). *Subastieria*[2] ("*Astieria*") *sulcosa* (Pavlow). *Subastieria* ("*Astieria*") aff. *sulcosa* (Pavlow). *Subastieria* ("*Astieria*") **decipiens** sp. nov. (="*atherstoni*" Pavlow, x, 14). *Subastieria* ("*Astieria*") *trisulcosa* (Phillips). *Subastieria* ("*Astieria*") aff. id. (="? *spitiensis*" Danford, xi, 6). *Olcostephanus* ? ("*Astieria* ?") **subfilosus** sp.n. (="*astieri*" Pavlow, x, 15). *O.* ? ("*Astieria*" ?) aff. id. (="*astieri*" Danford, xi, 7).

C_8. *Acanthodiscus* **lamplughi** sp.n. ("*amblygonius*" Danford, xiii, 4). *Lyticoceras regale* (Bean MS.) Pavl. sp. *L. regale* var. *oxygonius* (Pavl. non Neum. & Uhlig). *L. regale* var. *amblygonius* (Pavl. non Neum. & Uhlig). *Barremites subcassida* nov. *Subastieria* ("*Astieria*") *sulcosa* (Pavlow). *Subastieria* ("*Astieria*") aff. *sulcosa* (Pavlow). *Olcosteph.* ? ("*Astieria* ?") *subfilosus* sp.n. *Parastieria*[3] *peltoceroides* (Pavlow). *Spitidiscus* **subrotula** sp.n. ("*rotula*" Phill. non Sowerby). *S.* **inflatiformis** sp.n. ("*rotula*" Pavlow, x, 12). **Speetoniceras**[4] *inversum* (M. Pavlow). *S. subinversum* (M. Pavlow). *S. versicolor* (Trautschold). *S.* **subbipliciforme** sp.n. (="? sp." Danford, pl. xii, fig. 3). *Simbirskites* ? *concinnus* (Phillips). **Ægocrioceras**[5] *intermedium* (Phillips). *Crioceras plicatile* (Phillips).

C_7. *Lyticoceras regale* (Bean MS.) Pavlow sp. *Subastieria* ("*Astieria*") *sulcosa* (Pavlow). *Subastieria* ("*Astieria*") sp. nov. ? *Spitidiscus* aff. *rotula* (Sow.). *Speetoniceras subinversum* (M. Pavlow). *S. subbipliciforme* nov. *Simbirskites* ? cf. *concinnus* (Phillips). *S.* cf. *elatus* v. Koenen non Trautschold sp. *S.* sp. juv. cf. *payeri* ? (Toula) Pavlow.

[1] "Fauna d. Neocomsandst. i. Teutob. W." : *Pal. Abh.*, vol. ii, 1884, pt. i.

[2] The genus *Subastieria* was proposed for this *sulcosus*-group in "Monograph of the Ammonoidea of the Gault", (Pal. Soc.), vol. for 1921 (1923), p. 32.

[3] The genus *Parastieria* for "*Acantoceras* (?)" *peltoceroides* Pavlow (1892, p. 152, pl. x, figs. 20, 21), obviously a derivative of the group of "*Astieria*" *sulcosa* Pavlow, was proposed by the writer in "Ammonite Horizons of the Gault and Contig. Format." : Summary Progress for 1922 : *Geol. Surv.*, 1923, p. 144.

[4] Gen. nov. (genotype : *S. subbipliciforme* nov.). See Pal. Notes below.

[5] Gen. nov. for "*Crioceras*" *capricornu* (Roemer) Pavlow (1892, p. 154, pl. xi, fig. 9), differing from *Crioceras* s.s. (*duvali* group) in ornament and suture-line, but connected with it by such forms as *Æ. seeleyi* (Neum. & Uhlig).

C_7 (and C "lower to middle"). *Crioceras plicatile* (Phillips). *C. plicatile* (Bean MS., non Phillips). *C.* aff. *jurense* Kilian. *C.* aff. *nolani* Kilian. *C.* aff. *cornuelianum* (d'Orb.) = "cf. *matheroni*" Pavlow, xi, 10. *C.* sp. nov. ? (Neumayr & Uhlig, lvi, 3).[1] *C. beani* (Young & Bird = cf. "*Toxoceras*" *bituberculatum* d'Orb.). *C.* aff. *hildesiense*, v. Koenen. *C.* aff. *wermbteri* v. Koenen. *Ægocrioceras intermedium* (Phillips). *A. intermedium* (Bean MS., non Phillips). *A. raricostatum* (Phillips). *A. capitanei* (Bean MS.). *A.* sp.n. aff. id. (= "*puzosianum*" v. Koenen in Danford = *quadratum* (Bean MS., "var.")). *A. subnodosum* (Roemer). *A. cristatum* Pavlow non d'Orbigny sp. *A. quadratum* (Bean MS.) Crick sp. *A. semicinctum* (Roemer). *A.* cf. *semicinctum* (Roemer) [= *insigne* Pictet ?]. *A.* sp. nov. ? aff. *semicinctum* (Roemer). *A. ligatum* (Bean MS.). *A. seeleyi* (Neum. & Uhlig.) (typus, lii, 2). *A.* **subseeleyi** nov. (= *alternatus* Phillips, i, 27 non 26 = "*matheroni*" v. Koenen in Danford). *A. capricornu* (Roemer). *A. torulosum* (v. Koenen). *A. bucklandi* (Phillips) Buckland sp. *A. bucklandi* var. (Bean MS.) (less compressed). *A.* sp. nov.? aff. *intermedium* ("cf. *duvali*" v. Koenen in Danford). *A.* **koeneni** sp. nov. (= "*Ham. maximus*" Phillips, i, 21).[2] *A.* sp. nov.

C_6. *Spitidiscus rotula* (Sowerby). *S. youngi* (Young & Bird) [= "*cassidoides*" Danford, xiv, 6, non Pavlow]. *S. subrotula* nov. *Simbirskites venustus* (Phillips). *S. triplicatus* v. Koenen. *S. payeri* (Toula) Pavlow. *S. speetonensis* (Young & Bird). *S. progredicus* (Pavlow, 1892 non auct.). *Subsaynella* ("*Saynella*") sp.n. (group of "*S.*" *sayni* = cf. *carteroni* in Lamplugh, 1896, table, p. 184). *Crioceras* aff. sp. nov. ? jam. cit. (Neum. & Uhlig, lvi, 3). *Ægocrioceras* aff. *cristatum* (Pavlow non d'Orb.). *A.* aff. *capitanei* (Bean MS.).

C_5. *Spitidiscus rotula* (Sowerby). *Crioceras* sp. juv. (*wermbteri* group ?).

C_4. *Simbirskites* aff. *kleini* (Neum. & Uhlig) ("*decheni*" Pavlow, 1892, non Roemer, "*marginatus*" auct. non Neum. & Uhlig, "*nucleus*" auct. non Roemer). *S.* sp. ind. aff. *elatus* (Trautschold non M. Pavlow). *S. progredicus* (Lahusen). *S.* aff. *inverselobatus* (Neum. & Uhlig) Weerth sp. ("*umbonatus*" Danford, xii, 6). *S. trifurcatus* (Bean MS.). *S.* aff. *lippiacus* (Weerth). **Craspedodiscus**[3] *phillipsi* (Roemer). *C. gottschei* (v. Koenen). **Paracrioceras**[4] **statheri** sp. nov. (= "*beani*" Phillips, i, 28, non Young & B.).

C_3. *Simbirskites* aff. *inverselobatus* (Neum. & Uhlig) Weerth sp. (= "*umbonatus*" Danford, xii, 6). *S.* cf. *fasciato-falcatus* (Lahusen). *S. progredicus* (Lahusen). *S.* sp. ind. (large, *kleini*-group). *S.* aff. *pseudobarboti* (Pavlow). *S. marginatus* (Phillips). *Craspedodiscus* sp. ind. (large, *phillipsi*-group). *C. gottschei* (v. Koenen). *Paracrioceras* ? sp. juv. (Pavlow, xi, 11).

C_{2-3}. *Simbirskites* aff. *toensbergensis* (Weerth) (= "*decheni*" Danford non Roemer, xii, 7).

C_2. *Simbirskites* sp. juv. cf. *inverselobatus* (Neum. & Uhlig).

C_1. *Simbirskites progredicus* (Lahusen). *S.* cf. *progredicus* (Lahusen). *S.* sp. n. aff. *progredicus* (Lahusen). *S.* aff. *toensbergensis* (Weerth) (= "*umbonatus*" Pavlow). *S.* sp. ind. (*kleini*-group, large). *S.* aff. *fasciato-falcatus* (Lahusen). *Craspedodiscus* aff. *gottschei* (v. Koenen). *C.* cf. *discofalcatus* (Lahusen). *C. discofalcatus* (Lahusen). *C.* sp. ind.

[1] "Ammonitiden a.d. Hilsbild. Nordd.": *Palæontogr.*, vol. xxvii, 1881' Lief. 3–6.

[2] *Geology of Yorks*, 2nd ed., 1835, p. 95, pl. i, fig. 21 only (non 20 = *Hamites insignis* Pictet).

[3] Gen. nov. (genotype: *C. clypeiformis* Judd non d'Orbigny). See Pal. Notes below.

[4] Gen. nov., genotype: *Crioceras occultum* Seeley (*Ann. Mag. Nat. Hist.*, III, vol. xvi, 1865, p. 246, pl. x, fig. 1). (Sedgw. Mus.)

(*phillipsi*-group, large). *Paracrioceras statheri* nov. **Hoplocrioceras**[1] *fissicostatum* (Roemer) Neum. & Uhlig. *H.* aff. *læviusculum* (v. Koenen).

B (base). *Craspedodiscus* aff. *discofalcatus* (Lahusen). *C. carinatus* v. Koenen. *Paracrioceras statheri* nov. *P. bicarinatum* (Y. & B.). *Hoplocrioceras fissicostatum* (Roemer) Neum. & Uhlig sp.

B (lower). *Paracrioceras* aff. *occultum* (Seeley). *P.* sp. juv. *P.* aff. *varicosum* (v. Koenen = "*strombecki*" Danford). **Pseudocrioceras**[2] cf. *abichi* (Bač. Simon.) *Anthula* sp. *Hoplocrioceras* sp. nov. (Yorks. Mus.). *H.* aff. *fissicostatum* (Roemer). *H.* aff. *nodulosum* (v. Koenen).

B (probably Cement Beds and lower). *Paracrioceras* aff. *tuba* (v. Koenen). *P. banksi* (Bean MS.) (Sedgwick Mus.). *P.* sp. nov. ("*banksi*" Yorks. Mus.). *P.* aff. *denckmanni* (Müller). *P.* cf. *woeckeneri* (v. Koenen). *P.* aff. *elegans* (v. Koenen). *P.* sp. nov.? (Scarborough Mus.). *P. occultum* (Seeley). *P.* cf. *sexnodosum* (Roemer). *P.* cf. *gigas* (Roemer, non Sowerby). *Hoplocrioceras* cf. *læviusculum* (v. Koenen). *H.* cf. *fissicostatum* (Roemer). *H. aculeatum* (Bean MS.). *H.* sp. nov. (Scarborough Mus.).

B (Cement Beds). *Melchiorites* ("*Desmoceras*") cf. *charrierianum* (d'Orb.). *Pseudosaynella plana* (Phillips non Mantell). *Hoplocrioceras*? sp.

B (top and upper). *Callizoniceras*? ("*Desmoceras*") sp.n. (*hoyeri* group). *Pseudosaynella plana* (Phillips non Mantell). *Aconeceras nisoides* (Sarasin) v. Koenen and spp. juv. *Parahoplitoides fissicostatus* (Phillips). *P.* aff. *tenuicostatus* (v. Koenen). *P. bodei* (v. Koenen). *P.* sp.n. (*læviusculus* group). *Ancyloceras* sp.n. aff. *pingue* (v. Koenen). *A.*? sp. nov. ?.[3] **Hemicrioceras**[4] sp. nov. (*rude* group). **Parancyloceras**[5] *bidentatum* (v. Koenen). *P. scalare* (v. Koenen). *P.*? sp.n. aff. *ægoceras* (v. Koenen). **Toxoceratoides**[6] *royeri* (d'Orb.) v. Koenen. *T.* aff. *royeri* (d'Orb.). *T.* cf. *plicatus* (v. Koenen). *T.* cf. *fustiformis* (v. Koenen, pars). *T. seminodosum* (Roemer). *T.* cf. *æquicingulatum* (v. Koenen). *T. rotundus* (Phillips, non *Helicoceras rotundum* Sowerby sp.). *T. rotundus* (Bean MS. non Phill.). *T. obliquatum* (Young & Bird). *T.* **sheppardi** sp. nov. ("*Ham. attenuatus*" Phillips, i, 25). *T.*? cf. *trispinosum* (v. Koenen, pars). *Leptoceras* cf. *parvulum* Uhlig.

Spilsby Sandstone.

A = Acre House; B = Bolingbroke; BH = Birken Hasen; C = Claxby; D = Donnington; G = Goulsby; H = Holton; N = North Willingham.

A, B, G, H, *Subcraspedites*[7] *plicomphalus* (Sowerby). B, *S.* sp. nov. (involute *plicomphalus*). B, *S. ptychomphalus* (Brown). C, *S.* aff. do.

[1] Gen. nov., genotype: *Ham. phillipsi* (Bean MS.) Phillips, *Geol. of Yorkshire*, pl. i, fig. 30, a form close to *Crioceras læviusculum* v. Koenen; to include also *Crioceras fissicostatum* (Roemer) Neum. & Uhlig, non v. Koenen?, and allied forms.

[2] Gen. nov., genotype: *Crioceras abichi* (Bač. Simon.) Anthula (*Beitr. Pal. Geol. Öst.-Ung.*, vol. xii, 1899, p. 124, pl. xii, fig. 1).

[3] A large fragment, resembling "*Heteroceras* sp. ind." in Haug, "Puez Alpe": *Beitr. Pal. Öst.-Ung.*, vol. vii, 1888, p. 222, pl. xiii, fig. 1.

[4] Gen. nov., genotype: *Crioceras rude* v. Koenen, 1902, loc. cit., p. 311, pl. xxxiv, fig. 1.

[5] Gen. nov., genotype: *Crioceras bidentatum* v. Koenen, 1902, p. 329, pl. xxxviii, figs. 1–3.

[6] Gen. nov., genotype: *Toxoceras royeri* (d'Orbigny) v. Koenen, 1902, p. 399, pl. xxxvii, figs. 7, 8.

[7] This genus (genotype: *Ammonites plicomphalus* Sowerby, *Min. Conchol.*, vol. iv, 1823, p. 145, pl. cccciv, non. pl. ccclix = *Ammonites ptychomphalus* Brown, 1889, emend. Spath) was proposed in "Blake Coll. Ammon. from Kachh, India": loc. cit., 1923.

D, *S.* sp. juv. BH, D, N, *S. stenomphalus* (Pavlow). B, *S.* sp. nov. (*pressulus*-like). H, *S.* sp. (*subpressulus*-like). A, B, *S.* sp.n. (*subditus* Pavlow non Trautschold). B, D, *S.* sp.n. (cf. *nodiger*, Pringle).

CLAXBY IRONSTONE.

A = Acre House ; BH = Benniworth Haven ; C and D, as above ; N = Normanby.

C, *Subcraspedites* aff. *subditus* (Pavlow non Trautschold). N, *S.* sp. ind. (aff. do.). D, *Polyptychites multiplicatus* (Pavlow non Roemer). D, *P.* sp. (*lamplughi*-group). BH, *P. ascendens* v. Koenen. BH, *P.* aff. *pyritosus* nov. BH, *P.* sp. ind. A, *P.* sp. juv. cf. *polyptychus* Pavlow non Keyserling sp. C, *P.* cf. *ramulicosta* Pavlow. BH, *Dichotomites* aff. *terscissus* v. Koenen. BH, *D.* spp. juv. BH, *D.* sp. ind. ("*obsoletecostatus*" Neum. & Uhlig). BH, *D.* sp. ind. (cf. *quadrifidus*, Bean MS., non v. Koenen). BH, *D.* cf. *beani* (Pavlow). A, *Neocraspedites* aff. *semilævis* (v. Koenen) and *carteroni* (d'Orbigny) Pictet sp. A, *Olcostephanus* ("*Astieria*") cf. *imbricatas* (Baumberger). A, *Lyticoceras* aff. *noricum* (Schlotheim). A, BH, *L.* sp. juv. A, *L.* cf. *oxygonium* (Neum. & Uhlig). D, "*Crioceras*" sp. ind. C, *Simbirskites* aff. *toensbergensis* (Weerth). C, *S.* aff. *fasciato-falcatus* (Lahusen).

TEALBY CLAY (Donnington).

Simbirskites aff. *kleini* (Neum. & Uhlig).

TEALBY CLAY (East Keal).

Dichotomites spp. juv.

TEALBY CLAY (Hundleby).

Polyptychites ramulicosta (Pavlow). *P. pyritosus* nov. *P. polyptychus* (Keyserling) Pavlow. *P. gravesiformis* (Pavlow).

TEALBY LIMESTONE.

Craspedodiscus barbotanus (Lahusen). *C. discofalcatus* (Lahusen). *C. phillipsi* (Roemer) Weerth sp. *C. bipinnatus* (Williamson MS.). *C. clypeiformis* (Judd non d'Orbigny). *Lytoceras* aff. *vogdti* Karakasch.

SNETTISHAM CLAY (Heacham).

Paracrioceras occultum (Seeley). *P.* aff. *varicosum* (v. Koenen = "*strombecki*" Danford non v. Koenen). *P.* sp. ind. *P.* cf. *elegans* (v. Koenen). *Acrioceras* cf. *tabarellii* (Astier). *A.* cf. *silesiacum* (Uhlig). *A.* ? sp. ind. *A.* ? sp. nov. ? *Hoplocrioceras* aff. *lævisculum* (v. Koenen).

CARSTONE (Hunstanton).

Parahoplitoides bodei (v. Koenen). *P. tenuicostatus* (v. Koenen). *P. lævisculus* (v. Koenen). *P. fissicostatus* (Phillips). *P.* spp. nov. *Stenhoplites* ? [Dufrenoyia] sp. nov. *Cheloniceras seminodosum* (Sinzow). *C. cornuelianum* (d'Orbigny). *C. albrechti-austriæ* (Hohenegger). *Ancyloceras* aff. *varians* (d'Orbigny). *A.* sp. nov. *A.* cf. *gracile* (Sinzow).

IV. SUMMARY OF CONCLUSIONS.

(1) The line at the base of the Cretaceous is drawn below the Spiticeratan age, but certain genera of the family *Spiticeratidæ* range lower. It is usual to include this age, as "Upper Berriasian", in the Cretaceous, and the "Lower Berriasian", which equals the Tithonian, in the Jurassic ; but to avoid confusion it seems preferable to use the term Infra-Valanginian for those early Cretaceous beds that are definitely below the (typical) horizons of the Calcaire Roux and Limonite of the Jura.

The position of *Subcraspedites* is somewhat doubtful. It is believed that the Russian Riasan beds with possibly derived Berriasellids of the Spiticeratan and Berriasellidan ages below,

represent a condensed deposit, like bed D_4 at Speeton or the Claxby Ironstone. Pavlow [1] thought he found eight species of these ammonites common to the Riasan beds and to what he called the "*stenomphalus* beds" of Alatyr, wrongly referred to the Platylenticeratan age; but both the "*Oxynoticeras*" and the "*Hoplites*" are new [2] and the writer suggested correlation of the latter with the *Hatchericeras* fauna of Patagonia.

It is customary to consider the *spasskensis* and *stenomphalus* zones boreal representatives of the (Mediterranean) *boissieri* zone, but it will be noticed that when truly contemporaneous beds are compared, the Mediterranean elements may be found in the "boreal" province (*Riasanites* and *Protacanthodiscus*, at Riasan, the Barremian *Lytoceras* aff. *vogdti* in the Tealby Limestone) and vice versa the "boreal" elements *Polyptychites*, etc., in southern deposits. It may be claimed that the sequence of events in Lower Cretaceous times is even now very incompletely known. Alpine-Mediterranean deposits, though often apparently homogeneous on account of marmorization and other changes, due to regional metamorphism, were probably formed under conditions of alternating deposition and penecontemporaneous erosion, just like their fragmentary equivalents of north-western Europe. The Neocomian succession of the South of France, as given in the accompanying table, almost certainly includes several gaps. Arguments based on a supposed relationship of successive ammonites are also generally worthless. There is no reason why the deposition of the zone of *Kilianella roubaudiana*, with Neocomitids, should not have been separated from that of the zone of *Thurmannites boissieri*, with the last *Berriasellidæ*, by a very long time interval; but the persistence, in southern sediments, of the fundamental genera *Phylloceras* and *Lytoceras*, from which were derived all the trachyostracous offshoots that migrated into more northern waters, gives the erroneous impression of continuity of deposition.

(2) The Speeton Clay does not represent a continuous succession from the Kimmeridgian to the Aptian. Resting on the Coprolite Bed (E) with derived Kimmeridgian ammonites of pre-"*pallasianus*" age, i.e. not of the uppermost Kimmeridgian, the lowest ammonitiferous beds at Speeton are already well up in the Valanginian and there is a complete absence of the uppermost Kimmeridgian, the whole of the Portlandian, the Tithonian (= Purbeckian), the Infra-Valanginian (= "Upper Berriasian"), and the lowest Valanginian formations. There is no trace even of the early *Polyptychites* (*brancoi* group) and the lower *Euryptychites* (*latissimus-diplotomus* group), of *Tolypeceras* (*marcoui* group) and

[1] "Le Crétacé Infér. de la Russie, etc.": *Nouv. Mém. Soc. Imper. Nat. Moscou*, vol. xvi, 1901, p. 39.

[2] New genera for these forms were proposed by the writer (*Q.J.G.S.*, vol. lxxix, 1923, p. 307).

III. CORRELATION TABLE.

Subdivisions of the Neocomian.

Stages.	Ages.	Zones.	Speeton.	Lincs. and Norfolk.	North Germany.	Russia.	South of France.	Other areas.
							Costid. recticostatus z.	Swinitza. Dj. Djaffa, Algeria.
Barremian.	Heteroceratan.	*pingue.*	Cement Beds.		×			
		innexum.			×			
		costellatum.			×			
		.....					*Heteroc. astierian.* z.	Wernsdorf and Gardenazza Beds. Dj. Djaffa, Algeria. Dj. Zaghuan, Tunis.
	Paracrioceratan.	*denckmanni.*			×			
		elegans.			×			
		roeveri.		Snettisham Clay.	×			Wernsdorf Beds, pars. S.E. Spain. Dj. Quach, Algeria. Venezuela. Trinidad. Colombia.
		.....	Lower B.				"*Crio.*" *emerici* z.	
		centrifuga.			×			
	Hoplocrioceratan.	*rarocinctum.*			×		"*Hopl.*" *angulicostat.* z.	
		clypeiforme.		Tealby Lst.		*discofalcatus* zone.		
		discofalcatus.						*Tozaster* Beds ?
Hauterivian.	Simbirskitan.	*progredicus.*	C_{1-3}	Tealby Clay (and Claxby) Ironstone ?).		*versicolor* zone.		
		phillipsi.	C_4		×			
		rotula.	C_5				"*Desmo.*" *sayni* z.	
		speetonensis.	C_6					
	Crioceratan.	*capitanei.*						
		capricornus.	C_7		×		*Crio. duvali* z.	
		.....						
	Lyticoceratan.	*sulcosus.*	C_8					
		regalis.	C_9					*Holcoptychites* and *pseudoregalis* Beds, Patagonia.
		ebergensis.	C_{10-11}		×			
		noricus.	D_{1-2}	Claxby	×			Derived blocks, Denmark.
		radiatus.		Ironstone.	×		*Acanthod. radiatus* z.	Rossfeld and Grodischt Beds. Haute rivian Marls. *Oosterella* Beds, Spain.
		psilostoma.			×			"*Astieria*" Marls. Uitenhage Beds. *Valanginites* Beds, Colombia. "*Holcosteph.*" Beds, Mazapil and Spiti.
	Hoplitidan.	.....					*Saynoc. verrucos.* and *Kil. roubaud.* z.	
		heteroptychus.			×	*polyptychus* zone.		
		bidichotomus.			×			
		tercissus.			×			
Valanginian.	Polyptychitan.	*ramulicosta.*	D_3	Hundleby Clay.	×			
		ascendens.	D_{4-6}		×	*keyserlingi* zone.		Calcaire Roux and Limonite, Jura ?
		brancoi.	?		×			
		diplotomus.			×			Green Harbour and *C. Staratchin*, Spitsbergen.
	Platylenticeratan.	*marcoui.*			×			
		heteropleurum.			×	[*Nikitinoceras* beds ?]		
		pseudograsianum.					?	Up. Teschen [and Spiti ?] Shales.
Infravalanginian.	Subcraspeditan.	*stenomphalum.*		Spilsby Sdst.	" Wealden "	*Subcraspedites* beds.		"*Simbirskites*" of Crimea [and Knoxville Beds ?].
		tolli.						
		spasskensis.						"Craspedites" of *C. Staratchin*, Spitsbergen.
	Spiticeratan.	*latior.*					*Thurmann. boissieri* z.	*Spiticeras* zones of Patagonia } Spiti
		damesi.						*Substeueroceras koeneni* z. of Patagonia } Shales of Himalayas.
		acutum.					"*Berr.*" *callisloides* z.	

[To face p. 80.

Platylenticeras (*gevrilianus-heteropleurus* group), but the few feet of clay below the pale beds (D_6) have not yielded ammonites.[1]

The term "Passage Beds" for the lower division of the Speeton Clay, as used on the Geological 1 inch map (sheet No. 55, N.S.), is thus inadmissable.

(3) The Spilsby sandstone is not of "Upper Volgian" or "Aquilonian" (Jurassic) age and contains neither *Craspedites*[2] nor *Garniericeras*,[3] but ammonites older than any found in the Speeton Clay. There is a general resemblance of these to the "*Craspedites*" of the Riasan beds of Russia, but the Lincolnshire species are probably not identical and certainly much later than the true "Aquilonian" *Craspedites*.

(4) The specimens from bed D_4, generally misidentified with *Craspedites* and *Garniericeras*, are young *Polyptychites* (and *Dichotomites* ?) as suggested by v. Koenen[4] more than twenty years ago, though this author also described similar immature forms from ferruginous nodules in the "*oxynotus*" bed (*marcoui-heteropleurus* zones). At Speeton they are associated with forms referable to the comparatively late *ascendens* zone.

(5) The common drift specimens of Speeton *Polyptychites*, e.g. of the Holderness coast, come from an equivalent of the *ramulicosta* and *ascendens* zones (D_3 and D_4) at Speeton, and are now found in situ in a similar mode of preservation only in the "Tealby Clay" of Hundleby, Lincs. A specimen of *Polyptychites* cf. *triplodyptychus* Pavlow, from Culgower, Scotland, in the British Museum (No. C. 13209) is probably from beds of the same age.

(6) There is another (local ?) gap in the succession at the top of the Valanginian. Ammonites of the uppermost horizons, e.g. *bidichotomus*, *heteroptychus*, and *psilostoma*, and of the lowest Hauterivian *radiatus* zone, i.e. the faunas of Baumberger's[5] *Astieria* Marls and Hauterivian Marls, occur derived in the black nodules of bed D_2, but are associated already with *Lyticoceras noricum* and allies.

The Claxby Ironstone of Lincolnshire, also containing true "*Astieria*", seems to represent a similar mixed deposit, with derived

[1] The cast, on an *Exogyra*, of part of a large ammonite, recorded by Mr. Lamplugh (*Q.J.G.S.*, 1896, p. 200, footnote 3), was stated to be insufficient for specific determination, but possibly "akin to the *Craspedites* group of *Olcostephani*". It shows that curious backward bend of the costæ on the umbilical slope, found in many large *Polyptychites* of the *brancoi* group, but is unfortunately quite indeterminable.

[2] J. Pringle, "Pal. Notes on the Donnington Borehole of 1917": *Summary of Progress, Geol. Surv. for* 1918 (1919), Appendix iii, p. 50.

[3] Salfeld, "Glied. d. Ob. Jura in N.W. Europa": *N.J. f. Min.*, Beil.-Bd. xxxvii, 1914, table to p. 128, evidently in error, quotes "*Platylenticeras caletanum*".

[4] "Ammonitiden d. Nordd. Neocom.": *Abh. k. Preuss. Geol. L.A.*, etc., N.F., Heft 24, 1902, p. 440.

[5] "Ammonitiden d. Unt. Kreide im W. Schweiz. Jura," pt. vi: *Abh. Schweiz. Pal. Ges.*, vol. xxxvi, 1910, pp. 41–5.

ammonites of the Hundleby Clay and Spilsby Sandstone on which it rests non-sequentially. But the youngest forms there are *Simbirskites*, so that it is presumed to include two deposits of different dates, the lower corresponding to bed D_2 at Speeton, the higher to the *phillipsi* zone of the Hauterivian; but there is no evidence as to the position of the fossils in the few feet of Ironstone and as to whether the two *Simbirskites* (in the Sedgwick Museum) came from the clayey band at the top of the Ironstone.[1]

(7) The true *Ammonites noricus* occurs only at the extreme base of the "*noricus* zone" of Professor Judd, having its maximum occurrence at about one foot above the nodules of bed D_1. The ammonite generally misnamed "*A. noricus*" is *Lyticoceras regale*, with its maximum in bed C_9, but occurring already in C_{11} and C_{10} and gradually dying out in beds C_8 and C_7. The advantage of using only the smallest units for correlation is evident; for in North Germany there is apparently a local gap between the *ebergensis* and *capricornu* horizons, or at least a less complete sequence.

(8) The Crioceratan age may include the *duvali* zone of Southern France; for pyritized *Simbirskites* comparable to forms of C_8 occur at Barrème, Basses-Alpes (B.M. No. 73463, Astier Coll.), above the *duvali* beds, but appear to be missing in most Mediterranean areas. The Spiti *Simbirskites* described by Uhlig,[2] Burckhardt's[3] *Simbirskites mexicanus*, and Douvillé's[4] Argentine species, probably also Karakasch's *S. auerbachi* (Eichw.),[5] have been misidentified generically; but a form of the group of "*Saynella*" *sayni* has been found in the Simbirskitan bed C_5 at Speeton.[6]

(9) The Tealby Clay (of Donnington, etc.) represents the *progredicus* zone, and the Tealby Limestone the *discofalcatus* and *clypeiformis* zones. After the Tealby Limestone follows another unconformity in Lincolnshire; and a break in the North German succession is indicated by the sandy *rarocinctus* bed.

(10) *Hoplocrioceras* of the type of *H. fissocostatum* (Römer) Neumayr and Uhlig (non v. Koenen and Stolley ?) occur in the top beds of C and the base of B, but the correlation with the somewhat similar *Pseudothurmannia* ("*Crioceras*") *angulicostata* (d'Orbigny) Pictet sp. is quite tentative.

(11) The *Paracrioceras* of the *roeveri* and *elegans* zones resemble, but are not identical with, those of the *emerici-barremense* group of

[1] Lamplugh, loc. cit., 1896, p. 201.

[2] "Fauna of the Spiti Shales": loc. cit., fasc. ii, 1910, pl. xlv A, fig. 1.

[3] "Faunes Jurass. & Crét. de San Pedro del Gallo": *Bol. Inst. Geol. Mexico*, vol. xxix, 1912, p. 129, pl. xxxiv, figs. 18, 19, 21, 22.

[4] "Céphalop. Argentins": *Mém. Soc. Géol. France*, Pal. No. 43, 1910, pl. xix, figs. 3, 4.

[5] "Le Crétacé Infér. de la Crimée, etc.": *Trav. Soc. Imp. Nat. St. Pétersb.*, vol. xxxii, 1907, p. 130, pl. xiii, figs. 1–5.

[6] Lamplugh Coll., labelled "probably C_6" and recorded (loc. cit., 1896, table, p. 184) as *Olcostephanus* (*Simbirskites*) cf. *carteroni* d'Orb. (Professor Pavlow's identification).

the South of France. On the other hand, in the corresponding Snettisham Clay, *Acrioceras* of the group of *A. tabarellii* (Astier) and *A. silesiacum* (Uhlig) have been found associated with these *Paracrioceras*. The Barremian at Speeton, as probably at any other single locality, is very incomplete, and even if bed B be found to include all the zones of the North German succession, there must be some gaps. There is no trace of the Astieridiscan, Pulchellian, Heinzian, and Heteroceratan faunas, all of which include " hoplitid " or trachyostracous developments that are unknown in the North, but probably not on account of climatic differences.

The insertion of the Barremian faunas in the table is thus provisional. The " *Crioceras* " zones here given almost certainly represent only a small proportion of (ideal) Barremian time, and the gaps in the table may have been placed at incorrect levels.

(12) The *pingue* zone, in which *Pseudocrioceras* (and in Germany *Barremites* and *Holcodiscus*) have been found, is doubtfully classed as the highest Barremian (Heteroceratan ?) and is followed by the Parancyloceratan age given in a previous table.[1]

(13) The lower Aptian black clays, forming the top of B, and having *Parahoplitoides fissicostatus* of the *bodei* zone above and *Aconeceras* and *Parancycloceras bidentatum* below, are not immediately overlain by the Albian clays of the *cristatus-orbignyi* zones, from which *Anahoplites trifidus* Spath (W. C. Hey Coll., Yorkshire Museum) probably was collected. There are intermediate beds of greater thickness than originally observed by Mr. Lamplugh[2]; and Mr. Stather once measured a section with five feet of these " *ewaldi* " clays below the Gault. The Middle and Lower Albian fossils examined by the writer are *Hoplites* cf. *dentatus* (Sowerby), *Leymeriella* cf. *hitzeli* Jacob, and *Gaudryceras* cf. *œolum* (d'Orbigny).[3] The latter two would be expected to occur in the German *strombecki* beds of Leymeriellan age, not the *ewaldi* zone (Parahoplitoidan age). Though Professor Judd was right, therefore, in assuming a great unconformity at the top, as at the base of the Speeton Clay, the sequence of events between the Lower Aptian and Upper Albian was probably far more complex than is generally believed. It seems evident, however, that about 800 feet of Aptian beds in the Isle of Wight are unrepresented at Speeton, and that, although there was a Lower Gault transgression, the Albian succession of Speeton is as incomplete as the Aptian.

V. Palæontological Notes.

The desmoceratid genera here mentioned will be discussed in more detail in the Monograph of the Ammonoidea of the Gault, but it may be useful to review here the Crioceratids of

[1] Spath, loc. cit., *Summary Progress*, 1923, p. 147.
[2] Loc. cit., 1889, Diagram section, fig. 8, p. 618.
[3] This was determined as " *Hoplites* ? " by Dr. A. v. Koenen (M.P.G. 17043).

the Speeton Clay and their classification, also that of certain Olcostephanids and Hoplitids.

The earliest British Crioceratids of the Lower Hauterivian beds D_2 and D_1 are referred to *Distoloceras*, and are merely uncoiling forms of the group of *D. hystrix* (Phillips). No representative of the Valanginian group of "*Crioceras*" *curvicosta* v. Koenen, for which the new genus **Juddiceras** g.n.[1] is proposed, has yet been found at Speeton, and it may be added that the *terscissus* group of *Dichotomites*, which are contemporaries of *Juddiceras*, is also apparently absent in Yorkshire.

The true *Crioceras*, with two types of costæ, are found chiefly in beds C_8 and C_7. They are probably partly derived from *Lytoceras*, partly connected with Desmoceratids (and thence *Phylloceratidæ*) by way of *Spitidiscus*, whereas the first two Crioceratid types discussed above belong to the "family" Neocomitidæ, that is to say, they are connected with *Neocomites* and allied genera by morphological transitions and close association in date of existence. The true Hauterivian *Crioceras* do not, however, at Speeton include forms identical with the well-known *Crioceras duvali* and *C. villersianum* d'Orbigny. They are associated with numerous capricorn forms, here referred to the new genus *Ægocrioceras*, with forms of the type of *Ægocrioceras seeleyi* (Neumayr and Uhlig) as transitional links.

In upper C and lower B *Hoplocrioceras* is common. The bundling of the ribs at the umbilical tubercle is similar to that found in *Ammonites mortilleti* (Pictet and de Loriol), with which these forms of the *fissicostatus* group had been identified by Judd. The *Pseudothurmannia*[2] of the *angulicostatus* zone of the South of France may represent the Hoplitid stock from which sprang these Crioceratids. *Uhligia* v. Koenen (*minutus* group), which is probably a "degenerate" Hoplocrioceratid, is not known from Speeton.

Paracrioceras of the Lower Barremian is characterized by highly tuberculate ornamentation and includes also the Mediterranean *emerici* group, whereas its probable derivative *Pseudocrioceras* (*abichi* group) comprises forms with trituberculation tending to appear also on the finer intermediary ribs and much more massive whorls.

In the Snettisham Clay, *Paracrioceras* is associated with another member of the Crioceratidæ, namely *Acrioceras* (*tabarellii* group), but Kilian,[3] no doubt in error, has recorded this also from the Aptian of the Paris Basin. On the other hand, **Lytocrioceras** gen. nov. for

[1] Genotype: *Crioceras curvicosta* v. Koenen, loc. cit., 1902, p. 326, pl. l, fig. 1.

[2] With **Hemihoplites**, gen. nov. (genotype: *Ammon. ferarudianus*, d'Orbigny) and **Metahoplites**, gen. nov. (genotype: *Hoplites henoni* [Coquand] Sayn) included in Hemihoplitidæ.

[3] In Frech, "Lethæa Geogn.," ii. Mesoz. 3. Kreide, pt. i, Unter-Kreide, fasc. iii, 1913, p. 351.

the group of *Ancyloceras jauberti* Astier,[1] including loosely coiled and finely ribbed forms that may represent extreme modifications of the Hauterivian Crioceratidæ and lead to "*Hamulina*" and "*Ptychoceras*" types, is not represented at Speeton, nor are the various Barremian Heteroceratidæ, including *Heteroceras* (with one possible exception), *Atopoceras*, *Dirrymoceras*, *Hemibaculites*, and *Lindigia*. Ancyloceratid or other types of coiling, common after the Hauterivian, are not considered of generic importance, but it will be seen that the sharp distinction between "hoplitid" *Crioceratidæ* and lytoceratid "*Macroscaphitidæ*" cannot be upheld.[2]

The "degenerate" *Paracrioceras* of the *robustum* and *denckmanni* types, occurring in "Cementstone" nodules, have not yet been found "in place" at Speeton. But the Aptian Ancyloceratid genera of Upper B include *Parancyloceras*, established for the *bidentatus-ægoceras* group, with very characteristic costation, and *Toxoceratoides* for the trituberculate *royeri* group. The group of "*Ancyloceras*" *rude* v. Koenen, for which the new genus *Hemicrioceras* is proposed, is represented only by a form that is apparently new; but *Crioceras deeckei* Favre,[3] which has been compared to "*Ancyloceras*" *rude*, is quite distinct, and probably much earlier, and requires a new generic designation: **Peltocrioceras** gen. nov.

The true *Ancyloceras* (*matheronianus* group) is represented in the Hunstanton Carstone, but, like *Leptoceras*, more doubtfully at Speeton, and *Helicancylus* and *Tonoceras* are altogether absent. *Ancyloceras matheronianum* (d'Orbigny) itself occurs in the *Perna* Bed of Atherfield, but this has not yielded *Parahoplitoides bodei*, common at Speeton and in the Carstone of Hunstanton. The still later Lower Greensand genera *Tropæum*[4] (*bowerbanki-gigas* group), *Ammonitoceras* (*transcaspius*[5] group), and **Tonohamites** gen. nov. for *Hamites decurrens* (Roemer) v. Koenen[6] also do not occur at Speeton. On the other hand, there are some Gault Hamitids (*Anisoceras*) in the Museums of York and Hull, but their mode of preservation and association with, e.g. Cambridge Greensand specimens, make it desirable to await confirmation of their occurrence at Speeton.

[1] *Cat. descript. Ancyloceras*, 1851, p. 25, pl. ix, No. 17 (holotype: B.M. 46882).

[2] Spath, "Notes on Ammonites": Geol. Mag., N.S., Dec. VI, Vol. VI, 1919, pp. 30, 220.

[3] "Die Ammon. d. Unt. Kreide Patagoniens": *N. Jb. f. Min.*, etc., Beil.-Bd. xxv, 1908, p. 636, pl. xxxvi, f. 4; pl. xxxvii, f. 1.

[4] On a former occasion (Spath, "Cret. Ammon. Angola": *Trans. Roy. Soc. Ed.*, vol. liii, pt. i, 1922, p. 111) included in *Parahoplitidæ*, with *Ammonitoceras*, but they are probably independent *Lytoceras* (*Cicatrites*) derivatives.

[5] Sinzow, "Untersuch. einig. Ammonitiden aus dem Unt. Gault Mangyschlaks, et.": *Verh. Russ. K. Min. Ges.* (II), vol. xlv, 1907, p. 510, pl. vi, figs. 9–12.

[6] Loc. cit., 1902, p. 392, pl. xxxiii, fig. 3, from the Aptian of Ahaus, which was wrongly placed by Stolley (loc. cit., 1908, p. 220) *below* instead *above* the *deshayesi* zone.

Of importance for correlation is the discovery, in bed D_2 at Speeton, of the baculoid genus *Bochianites*, which is widely distributed, from Europe to South Africa and the Himalayas on the one hand, and to Colombia on the other. It may be considered a straightened-out Neocomitid of the *Juddiceras* type, rather than a derivative of the Tithonian **Protancyloceras** gen. nov. (for *Ancyloceras gümbeli* Oppel [1]), which appears to produce *Bochianites*-like developments.[2]

To show the diversity of the heteromorphous Ammonoidea occurring at Speeton, it may be advisable to list them in the following summary :—

Fam. NEOCOMITIDÆ : *Distoloceras* Hyatt ; *Bochianites* Lory.

Fam. CRIOCERATIDÆ : *Crioceras* Leveillé ; *Ægocrioceras* nov. ; *Paracrioceras* nov. ; *Pseudocrioceras* nov. ; *Acrioceras* Hyatt.

Fam. HEMIHOPLITIDÆ : *Hoplocrioceras* nov.

Fam. HETEROCERATIDÆ : (?) *Heteroceras*.

Fam. ANCYLOCERATIDÆ : (?) *Ancyloceras* d'Orbigny ; (?) *Leptoceras* Uhlig ; *Parancyloceras* nov. ; *Toxoceratoides* nov. ; *Hemicrioceras* nov.

Fam. ANISOCERATIDÆ : (?) *Anisoceras* Pictet.

Apart from the uncoiled forms, ammonites at one time included in "*A. astierianus* d'Orbigny" often cause difficulty in identification. Professor Judd was right in putting his "*astieri* zone" (D beds) below the "*noricus* zone" (lower C), but he may have applied the term "*astieri*" also to the far commoner Polyptychitids. The main development of *Olcostephanus*, of which *A. astieri* is the genotype, is at the base of the Hauterivian and uppermost Valanginian ("*Astieria* Marls" and "*verrucosus* zone" of southern equivalents). The ammonites of these horizons, with very rare *Olcostephanus*, are found at Speeton as phosphatic casts in bed D_2, but associated already with *Lyticoceras noricum*.

Professor Pavlow's "*Astieria*", on the other hand, include, in addition to some doubtful *Olcostephanus*, that may be transitional from the earlier *astieri*-group, a well-defined assemblage of small forms for which the new genus *Subastieria* was proposed. This *sulcosus*-group is characterized by its highly coronate whorls, and *Parastieria peltoceroides*, hitherto confused with the Cenomanian *Acanthoceras*, is an extreme development of *Subastieria sulcosus*, very distinct also from *Valanginites* (group of *A. perinflatus* Matheron) and from *Rogersites* gen. nov. (genotype : *Olcostephanus modderensis* Kitchin [3]). The latter develops gigantic sphærocones

[1] In Zittel, "Die Fauna der Älteren Cephalopoden-führenden Tithonbildungen" : *Palæontogr. Suppl.*, 1870, pl. xii (xxxvi), figs. 1*a–c*.

[2] Kilian (loc. cit., 1910, p. 187) quotes *Bochianites* in the fauna of the "*boissieri*-zone", which includes several Infravalanginian and Tithonian horizons, to judge by Kilian's lists.

[3] "The Invertebrate Fauna and Pal. Relat. of the Uitenhage Series" : *Ann. S. Afr. Mus.*, vol. vii, pt. ii, 1908, p. 202, pl. x, fig. 3.

before *Olcostephanus astierianus* becomes dominant, and is probably represented from Speeton by a small pyritized example, doubtfully compared to v. Koenen's "*Astieria*" *convoluta*,[1] and much closer to the South African group of *Rogersites atherstoni* (Sharpe) than Pavlow's figured specimen of this species, here renamed and referred to the genus *Subastieria*.

Simbirskites Pavlow, here restricted to the original coronate forms of the *decheni* group, is a later stock, again simulating the earlier Olcostephanidæ, and it may be recalled here that various Himalayan and Mexican forms of the genus *Grayiceras* Spath, of the Tithonian, have been wrongly referred to *Simbirskites* as well as Craspeditids and, e.g., what appears to be a Kimmeridgian *Rasenia*.[2]

It seems desirable to separate from *Simbirskites* s.s. the perisphinctoid early forms (*Speetoniceras* gen. nov., genotype: *S. subbipliciforme* nov.[3]), which show that the family Simbirskitidæ probably represent an independent branch of a ribbed Desmoceratid ("*Saynella*") stock. *Simbirskites*, via compressed forms of the group of *S. concinnus* (Phillips) and *S. speetonensis* (Young and Bird), is connected with the discoidal shells of *Craspedodiscus* nov., with *C. clypeiformis* Judd non d'Orbigny,[4] as the final, oxycone, stage. The discoidal branch persists later (to base of B) than the coronate group (ending in C). *Craspedodiscus weerthi* (v. Koenen) has some resemblance to *Neocraspedites tenuis* (v. Koenen), which is a development of the earlier family Polyptychitidæ. To judge by a Val de Travers example before me (B.M., No. C. 23192) of a new species allied to Pictet's specimens[5] of d'Orbigny's *A. carteroni*, included in "*Craspedites*" by e.g. Kilian[6] and Baumberger,[7] this group forms a further, unnamed, genus of the same family.

With regard to the hoplitid forms, the genus *Acanthodiscus* Uhlig is here restricted to the *radiatus* group, but only a few small forms are known from Speeton. This restricted *Acanthodiscus*, with its allies *Lyticoceras*, *Distoloceras*, *Leopoldia*, etc., may be included in a "family" Neocomitidæ, and is widely separated from a somewhat homœomorphous Berriasellid development, namely, *Protacanthodiscus*, established for the group of "*Hoplites*" *andreæi*. It is also necessary to separate from the restricted genus *Acanthodiscus* the group of *A. raimondi* Gabb = **Raimondiceras** gen. nov.,[8]

[1] Loc. cit., 1902, pp. 146, 412, pl. xxxix, fig. 4.

[2] In Skeat and Madsen, "On Jurass. Neocom. and Gault Boulders, etc.": *Danmarks Geol. Unders.* (II), No. 8, 1898, p. 194, pl. vii (*Olcostephanus* cf. *kleini*, Neum. & Uhlig).

[3] *Olcostephanus* [*Simbirskites*] ? sp. in Danford, loc. cit., 1906, pl. xii, fig. 3. See above, under II.

[4] See Lamplugh, loc. cit., 1896, p. 210.

[5] In Pictet and Campiche, *Ter. Crét. Ste. Croix*, 1860, p. 294, pl. xlii.

[6] In Frech, "Lethæa Geogn.," ii. Mesoz. 3. Kreide, pt. i, Unter-Kreide, fasc. ii, 1910, p. 210.

[7] Loc. cit., pt. v, 1908, p. 32.

[8] Genotype: *Hoplites* juv. *raimondii* (Gabb) in Lisson, *Geol. de Lima*, 1907, p. 41, pl. v, fig. 1.

with grooved, not flattened or convex periphery and strongly projected secondary ribs; further, **Octagoniceras** gen. nov., for the group of *Ammonites octagonus* (Strachey MS. Blanford),[1] more nearly allied to the Tithonian *Protacanthodiscus*, but with much more massive ornamentation.

Oosterella, a contemporary of the large Lower Hauterivian *Acanthodiscus*, is unknown from Speeton, as is **Pseudoosterella** gen. nov. for the group of "*Mortoniceras*" *fischeri* Nicklès,[2] and **Suboosterella** gen. nov. for *A. heliacus* d'Orbigny.[3] The latter stock, to judge by examples labelled *A. moutonianus* and *A. ixion* d'Orbigny in the Astier Collection (B.M., No. 73663, 73644), leads from the hoplitid ancestors to these keeled forms of *Oosterella*, but *Lyticoceras cryptoceras* (d'Orbigny), often confused with *Suboosterella* of the *salevensis* type, is also close, as is *Saynella*, the type of which (*S. clypeiformis* d'Orbigny sp.), like certain *Leopoldia*, however, represents a "catagenetic" offshoot.

Of the forms generally confused with *Neocomites* (*neocomiensis* group only) and *Lyticoceras*, here adopted for the group of *A. noricus* Schlotheim, to which d'Orbigny's *A. cryptoceras*, Hyatt's genotype, probably belongs, the group of *Neocomites calliptychus* Uhlig has to be separated with a new name, **Calliptychoceras** gen. nov.,[4] and the new genus **Odontodiscoceras** is proposed for *Neocomites odontodiscus* Uhlig.[5] The former is characterized by its development, unlike that of *Sarasinella*, proceeding from fine to coarse; the latter differs from both *Neocomites* and *Lyticoceras* in peripheral aspect and costation.

Burckhardt[6] restricted *Steueroceras* Cossmann (= *Odontoceras* Steuer) to the early forms of the "*boissieri*" zone; but the type *St. transgrediens* (Steuer)[7] is a Neocomitid of the "*radiatus* zone", and distinguished from *Neocomites* itself by the ventral furrow and specialized outer whorl, and from *Odontodiscoceras* also by its costation, whereas *Lyticoceras*, apart from a different periphery, has more strongly flexiradiate costæ than any of these Neocomitids. *Odontoceras malarguense* Steuer, of the zone of *Spiticeras damesi*, is not

[1] In Salter and Blanford, *Pal. Niti.*, 1865, p. 83, pl. xii, figs. 2*a*, *b*, holotype B.M., No. C. 5032.

[2] "Rech. Géol. Province Alicante, etc.": *Ann. Hébert*, vol. i, 1892, p. 191, pls. vii, viii.

[3] *Pal. Franç., Ter. Crét.* (I), 1841, p. 108, pl. xxv, figs. 1, 2. (The "subcarinate" venter is poorly illustrated.)

[4] Loc. cit. (Spiti Shales, pt. ii, 1910), p. 251, pl. lxxxvii, fig. 2.

[5] Ibid., p. 256, pl. lxxxv, fig. 1.

[6] Loc. cit., 1912, p. 163. The type of *Steueroceras*, namely *St. transgrediens* (Steuer), was erroneously considered to be an *Aulacostephanus*, which, however, includes "*Odontoceras*" *anglicum* Steuer.

[7] Cossmann (*Revue Crit. Pal.*, ii, 1898, p. 115) and Uhlig (*Spiti Shales*, 1910, p. 156) had already restricted Steuer's genus to "*Odontoceras*" *anglicum* and "*O.*" *transgrediens*. The first, an *Aulacostephanus* from the Kimmeridge Clay of Weymouth, was erroneously compared to the Argentine forms, so that "*O.*" *transgrediens* remains as the genotype.

related to *Steueroceras*, but represents a new stock, for which the name **Argentiniceras** gen. nov.[1] may be proposed. The topotypes of Steuer's species in the British Museum,[2] showing bundling of ribs on the inner whorls, make appear probable the connexion of *Argentiniceras* with certain Spiticeratid forms, e.g. *Himalayites mutatus* (Steuer), rather than the somewhat similar forms of Berriasellids (e.g. *Substeueroceras*).

With regard to the use of family names for ammonites, the reader is referred to previous papers.[3] I hold that the fundamental family *Phylloceratidæ*, with Lytoceratids, has continuously, throughout Jurassic and Cretaceous times, replenished the ammonite tribes and that, say, Hoplitidæ and Neocomitidæ are not derived from Berriasellidæ, any more than these originate in some previous Perisphinctid family. It is convenient to include in the family Olcostephanidæ a group of genera such as *Rogersites*, *Subastieria*, and *Parastieria*, that range themselves besides *Olcostephanus*, but it would be rash to assume a monophyletic origin of even this small family in Polyptychitidæ, or of the latter in the still earlier Spiticeratidæ, though these three families replace one another in time and are connected by morphological transitions.

When the true relations of every trachyostracous ammonite to the two persistent root-stocks of *Phylloceratidæ* and *Lytoceratidæ* have been determined, on the basis of careful zonal collecting and uninfluenced by erroneous views of "recapitulation", the present more or less arbitrary classification of ammonites may give way to a fundamentally different scheme. But already we can recognize the essential simplicity of ammonoid phylogeny, which makes appear a master-stroke the first subdivision, by Suess, of all post-Triassic forms into only three groups: *Phylloceras*, *Lytoceras*, and *Ammonites*.

[1] Genotype: *Odontoceras malarguense* Steuer, "Argentin. Jura-Ablag.": *Pal. Abh.*, N.F., iii, pt. iii, 1897, p. 55, pl. xx, figs. 1–3.

[2] B.M., Nos. C. 11204–5.

[3] See "Blake Collection of Ammonites from Kachh, India": loc. cit., 1923, and "Ammonites from New Zealand": loc. cit., 1923, p. 292.

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