XXXIV.—On the Geological Distribution of the *Rhabdophora*.
By CHARLES LAPWORTH, F.G.S. &c.

Part III. RESULTS.

[Continued from p. 285.]

(c) *Bala-Caradoc Formation*.

TABLE VI. Showing the Range of the Bala-Caradoc
Rhabdophora.

	Wales &c.		Hartfell Shale.				Girvan.			Scania &c.			N.E. America.							
	Conway.	Salop.	Cynghordy.	Lower.			Up.													
				C.-Wilsoni Zone.	D.-Clingani Zone.	P.-linearis Zone.	D.-complanatus Zone.	D.-anceps Zone.	Tralodden Beds.	Shallock Beds.	Drummuck Beds.	Carnalea, Ireland.	C.-Scharenbergi Zone.	O.-argentea Zone.	Trinucleus-Beds.	Lorraine Shales.	Lake St. John.	H.R. G., Toronto.	H.R. G., Montreal.	Cincinnati Group.
LEPTOGRAPTIDÆ.																				
Leptograptus flaccidus, Hall	..	..	..	*	*	*	..	..	*	..	..	*	..	..	..	..	..	*		
— capillaris, Carr.	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Amphigraptus radiatus, Lapw.	..	..	..	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— divergens, Hall	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	*	..	..	..	..
Pleurograptus linearis, Carr.	..	..	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..
DICRANOGRAPTIDÆ.																				
Dicellograptus anceps, Nich.	..	..	..	..	..	..	..	*	..	..	*	..	..	..	?	..	..	..	..	..
— caduceus, Lapw.	..	..	..	..	*	..	..	..	..	..	..	*	..	..	..	..	..	..	..	..
— complanatus, Lapw.	..	..	..	..	..	..	*	..	*	..	..	..	..	?	*	..	..	..	..	..
— elegans, Carr.	..	..	..	..	*	*	..	..	*	..	..	..	..	?	*	..	..	..	..	..
— Forchhammeri, Geinitz	..	..	*	*	*	..	..	..	*	..	..	..	..	*	..	..	..	..	..	..
— moffatensis, Carr.	..	..	..	..	*	..	..	..	?	..	..	..	..	..	..	..	..	..	..	..
— Morrisi, Hopk.	..	..	..	..	*	*	..	..	*	..	..	..	*	..	..	..	..	..	..	..
— pumilus, Lapw.	..	..	..	..	..	*	..	..	..	..	..	..	..	*	*	..	..	..	..	..
Dicranograptus Clingani, Carr.	*	..	?	..	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..
— Nicholsoni, Hopk.	..	..	..	*	*	..	..	..	..	..	..	..	..	..	..	..	..	..	*	..
— ramosus, Hall	..	..	..	*	*	..	..	..	*	..	..	..	..	..	..	..	..	..	..	..
DIPLOGRAPTIDÆ.																				
Climacograptus bicornis, Hall	..	..	?	*	*	*	*	*	*	..	..	*	*	*	..	*	..	..	*	*
— caudatus, Lapw.	..	..	..	..	*	..	..	..	*	..	..	..	*	?	..	..	..	..	..	..
— Scharenbergi, Lapw.	*	..	?	*	..	..	..	..	..	..	..	..	*	..	..	..	..	..	..	..
— tubuliferus, Lapw.	..	..	..	..	..	*	*	..	*	..	..	..	..	*	..	..	..	..	..	..
— typicalis, Hall	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	*
— Wilsoni, Lapw.	..	*	..	*	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Diplograptus aculeatus, Lapw.	..	..	..	..	..	*	..	..	*	..	..	..	..	..	..	..	..	..	..	..
— euglyphus, Lapw.	?	..	..	*	..	..	..	..	..	..	..	*	*	..	..	..	..	..	..	..

TABLE VI. (continued).

	Wales &c.			Hartfell Shale.		Girvan.			Scania &c.		N.E. America.		
	Conway.	Salop.	Cynghordy.	Lower.		Tralodden Beds.	Shalloek Beds.	Drummuck Beds.	Carnalea, Ireland.	C.-Scharenbergi Zone.	O.-argentea Zone.	Trinucleus-Beds.	Lorraine Shales.
				C.-Wilsoni Zone.	D.-Clingani Zone.	P.-linearis Zone.	D.-complanatus Zone.	D.-anceps Zone.					
<i>Diplograptus foliaceus</i> , <i>Murch.</i> . .	*	*	*	*	*	*	*	*	*	*	*	*	*
— <i>quadrimumcronatus</i> , <i>Hall</i>	.	.	.	.	.	*	.	.	.	.	.	*	.
— <i>perexcavatus</i> , <i>Lapw.</i>	.	.	.	*	.	.	.	.	*	*	.	.	*
— <i>socialis</i> , <i>Lapw.</i>	.	.	.	.	.	.	*	.	*	*	.	.	.
— <i>rugosus</i> , <i>Emmons</i>	.	.	.	*	.	.	.	*	*	*	.	*	.
— <i>putillus</i> , <i>Hall</i>	.	.	.	.	.	.	.	.	*	*	.	*	.
— <i>truncatus</i> , <i>Lapw.</i>	.	.	.	.	*	*	*	*	*	*	*	*	.
— <i>pristis</i> , <i>His.</i>	.	.	.	.	.	.	.	.	.	.	*	*	.
— <i>hudsonicus</i> , <i>Nich.</i>	.	.	.	.	.	.	.	.	.	.	.	*	*
<i>Cryptograptus tricornis</i> , <i>Carr.</i> . .	.	.	.	*	*	.	.	.	*	.	.	.	.
LASIOGRAPTIDÆ.													
<i>Lasiograptus Harknessi</i> , <i>Nich.</i>	.	.	.	*	*	.	.	.	*	.	.	.	.
— <i>margaritatus</i> , <i>Lapw.</i>	.	.	.	.	*	*	.	*	.	.	.	.	.
<i>Glossograptus Hincksi</i> , <i>Hopk.</i>	.	.	.	*	.	.	.	.	.	.	.	.	.
RETIOLITIDÆ.													
<i>Retiolites fibratus</i> , <i>Lapw.</i>	.	.	.	.	*	*	.	.	.	.	.	.	.
— ? <i>eucharis</i> , <i>Hall</i>	.	.	.	.	.	.	.	.	.	.	.	*	.

A cursory examination of the Table given above is sufficient to convince those who accept the data already brought forward of the total distinctness in palæontological features between the Graptolite faunas of the Bala and the Arenig. In the true Bala beds here cited not a single example of the families of the Dichograptidæ or Phyllograptidæ has hitherto been detected. So far as our present information enables us to judge, they appear to have become wholly extinct; and their place is occupied by the very distinct families of the Diplograptidæ and Dicranograptidæ. The Diplograptidæ, so feebly represented in the Arenig and Lower-Llandeilo rocks, are now the dominant forms. In every zone they occur in swarms, and of the two genera *Diplograptus* and *Climacograptus* it is doubtful which is the more prolific. The old genus *Cryptograptus*, however, which is by no means rare in the highest Arenig, and the individuals of which teem in the

Llandeilo-Glenkiln beds, here suddenly expires, almost upon the threshold of the Caradoc formation. The *Dicranograptidæ* and the allied group of the *Leptograptidæ* have here their point of culmination and extinction. In point of numerical abundance these two families almost divide the palm with the *Diplograptidæ* on several horizons in this formation; but, unlike the members of that family, not a single example of either seems to have outlived its highest zones.

Lower Caradoc (Hartfell).—The typical graptolitiferous deposit of this age is undoubtedly the Hartfell shales of the south of Scotland; and to the physical and palæontological scale there exhibited the extra-Scottish Graptolite-bearing Bala deposits must in the meantime be referred.

In the lower division of the Hartfell shales we recognize three successive zones, of which the lowest may be regarded as intermediate in its palæontological characters between the typical Glenkiln and Hartfell groups. To this transitional zone the majority of the forms common to the Glenkiln and Caradoc strata are as yet restricted. The zone has not yet been certainly detected outside the range of the Moffat shales, except perhaps in Girvan, where it is imbedded in strata full of Bala-Caradoc Crustacea.

The central (*Dicranograptus-Clingani*) zone of the Lower Hartfell is the most characteristic band, and is recognizable not only in the Moffat region, but also in Wales, Ireland, and Sweden, and it is, I suspect, no great distance below the typical Bala Limestone itself.

The highest (*Pleurograptus-linearis*) zone is remarkable for the extraordinary number of *Leptograptidæ* which it contains. This little family culminates upon this horizon, members of its dubiously distinct genera *Leptograptus*, *Amphigraptus*, and *Pleurograptus* occurring in crowds.

The genus *Dicranograptus*, Hall, is by no means uncommon in the Lower Hartfell beds generally; but it hardly appears to survive into the highest zone, above which it is wholly unknown. The well-known species *Dicranograptus ramosus* is almost worldwide in its geographical range; and so, in all probability, is the intimately allied *D. Nicholsoni*, Hopk.

The genus *Dicellograptus*, however, is the most predominant bifid form. Few of its species have a long range within the formation; and only three, viz. *Dicellograptus Forchhammeri*, Gein., *D. elegans*, Carr., and *D. Morrisi*, Hopk., are as yet known outside the limits of the south of Scotland.

Leptograptus flaccidus, Hall, ranges from the Glenkiln into the top of the Lower Hartfell, where it seems to expire with

the inconstant pseudo-genera that complete its special division of the family.

The numerous Diplograptidæ present are generally of long range; but *Climacograptus Scharenbergi*, Lapw., *Diplograptus euglyphus*, Lapw., *D. rugosus*, Emmons, and *D. perexcavatus*, Lapw., belong to the lower zones only, and *D. quadrimucronatus*, Hall, and *Climacograptus tubuliferus*, Lapw., are restricted to the upper beds.

Of the Lasiograptidæ we here seem to meet with the last survivors. *Lasiograptus Harknessi* is found in the lower strata, and *L. margaritatus*, Lapw., in the middle. The former is accompanied by the latest known forms of *Glossograptus*. Of new forms the most remarkable are the fore-runners of the true *Retiolites* with its superficial network, here represented by the strange forms *Retiolites fibratus*, Lapw., and *R. ? eucharis* of Hall.

Upper Caradoc (Hartfell).—In the Moffat area these strata are comparatively barren, and the known fossils are restricted as yet to two zones, one near the base of their subformation, the other at its summit. The former, which is seen as a narrow black seam in the "Barren Mudstones" of the shales, is crowded with a peculiar species of *Dicellograptus* (*D. complanatus*, Lapw.) and a few forms of Diplograptidæ. Scanty as are the fossils of this zone, its beds are easily identified thereby in Girvan, in Ireland, and even in Scandinavia, where they aid us in fixing the *Trinucleus*-shales of Southern Sweden as being of true Upper Bala age.

The second zone, that of *Dicellograptus anceps*, has even a scantier fauna, consisting as yet merely of the forms *D. anceps*, Nich., *Diplograptus truncatus*, Lapw., *Climacograptus bicornis*, Hall, and *C. scalaris*, His., var.; which, however, reappear unmodified in the Drummuck beds at the summit of the Bala of Girvan, and are also present in the *Trinucleus*-beds of Sweden.

The mortality in families, genera, and species of *Rhabdophora* in the Upper Caradoc beds is extraordinary. The entire families of the Diceranograptidæ, Leptograptidæ, and Lasiograptidæ disappear from sight altogether. The only families that survive into the Llandovery are those of the Diplograptidæ and Retiolitidæ, and these only in a very degenerate form. With the exception of a doubtful variety of the conventional species *Climacograptus scalaris* of Hisinger, not a single form found in the Bala rocks has hitherto been met with in strata of Llandovery age; so that, as far as the *Rhabdophora* are concerned, the palæontological break between the Ordovician and Silurian systems seems to be complete.

SILURIAN SYSTEM (*Upper Silurian of Murchison*).*Valentian or Llandovery-Tarannon Formation.*

TABLE VII. Showing the Range of the Lower (and Middle) Valentian Rhabdophora.

	Cardigan †.		Coniston Mudstone.		Birkhill Shales.		Girvan.	Ireland	Sweden.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
	(C)	Machynlleth.	(C)	Cefn Symlog.	(C)	M.-tenuis Zone.	(A)	D. acuminatus &c.	(B)	M.-gregarius Zone.	(C)	M.-Sedgwicki Zone.	(C)	R.-marinus Zone.	(A)	Mullock-Hill Beds.	(B, C)	Saugh-Hill Shales.	(A, B)	Coalpit-Bay Beds.	(A-C)	Upper Pomeroy Beds.	(B, C)	M.-lobiferus Zone, Scania.	(B)	M.-lobiferus Zone, Westrog.	(B, C)	Kallholn Schist, Dalarne.	(A-C)	Thuringia, Germany.	(C)	Bohemia.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
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† The Rhabdophora enumerated in the first two columns of this table have been identified by myself in a collection of fossils recently obtained from the comparatively barren Silurian strata of Cardiganshire (the Lower Llandovery of the Survey publications) by Professor Keeping, who has generously permitted me to anticipate here the publication of this most important discovery. To the Graptolithologist this list is, indeed, most valuable; for no Rhabdophora have hitherto been quoted from the undisputed Llandovery strata of Wales.

TABLE VII. (continued).

	(C)	Machynlleth.	Cardigan.
	(C)	Cefn Symlog.	
	(C)	<i>M. tenuis</i> Zone.	Conistone Mudstone.
	(C)	<i>M. argenteus</i> Zone.	
	(A)	<i>D. acuminatus</i> &c.	
	(B)	<i>M. gregarius</i> Zone.	Birkhill Shales.
	(C)	<i>M. Sedgwicki</i> Zone.	
	(C)	<i>R. maximus</i> Zone.	
	(A)	Mullock-Hill Beds.	Girvan.
	(B, C)	Saugh-Hill Shales.	
	(A, B)	Coalpit-Bay Beds.	Ireland.
	(A-C)	Upper Pomeroy Beds.	
	(B, C)	<i>M. lobiferus</i> Zone, Scania.	
	(B)	<i>M. lobiferus</i> Zone, Westrog.	Sweden.
	(B, C)	Kallholn Schist, Dalarne.	
	(A-C)	Thuringia, Germany.	
	(C)	Bohemia.	
Monograptus intermedius, Carr.	*	*	
— leptotheca, Lapw.	*	*	
— lobiferus, M' Coy	*	*	
— proteus?, Barr.	*	*	
— runcinatus, Lapw.	*	*	
— Sandersoni, Lapw.	*	*	
— Sedgwicki, Portl.	*	*	
— spiralis, His.	*	*	
— Salteri, Lapw.	*	*	
— turriculatus, Barr.	*	*	
— tenuis, Portl.	*	*	
— triangulatus, Harkn.	*	*	
DIPLOGRAPTIDÆ.			
Diplograptus (Dimorphograptus)			
— elongatus, Lapw.	*	*	
— (—) Swanstoni, Lapw.	*	*	
— acuminatus, Nich.	*	*	
— confertus, Nich.	*	*	
— folium, His.	*	*	
— Hughesi, Nich.	*	*	
— insectiformis, Nich.	*	*	
— modestus, Lapw.	*	*	
— palmeus, Barr.	*	*	
— physophora, Nich.	*	*	
— sinuatus, Nich.	*	*	
— vesiculosus, Nich.	*	*	
Cephalograptus cometa, Gein.	*	*	
Climacograptus normalis, Lapw.,			
— var.	*	*	
— tectus, Barr., var.	*	*	
— rectangularis, M' Coy, var.	*	*	
— innotatus, Nich.	*	*	
RETIOLITIDÆ.			
Retiolites perlatus, Nich.	*	*	
— Daironi?, var., Lapw.	*	*	

This fauna reminds us at once of that of the Arenig formation in the extraordinary predominance of a single family of the Rhabdophora. The Monograptidæ, of which a few scattered examples are found for the first time in some of the lowest Llandovery beds, multiply so rapidly that long before we reach the middle beds of the Valentian formation they have become the dominant family. For a time the Diplograptidæ hold their own, as if contesting every horizon; but at the very commencement of the Tarannon period the issue is practically decided. One by one the species of the Diplograptidæ sink out of sight; and when the true Wenlock is reached the last has vanished. A Retiolite form occurs alone for some time longer; but in the Lower Ludlow the *Monograptus* reigns unchallenged, the solitary survivor of its race.

As in the case of the Glenkiln and Caradoc formations, we turn to the south of Scotland for our typical Graptolite-bearing rocks of Valentian age, where they compose the Birkhill shales and the overlying Gala group. These strata have been so minutely searched for Rhabdophora that there seems to be an uninterrupted zoological gradation from the base to the summit of the formation. In the entire series we seem at present to recognize five subgroups of tolerably equal systematic importance—the (1) Lower, (2) Middle, and (3) Upper Birkhill shales, and (4) (5) the Gala and Grieston groups. Of these, nos. 1, 2, and 3 are possibly included in the so-called Lower Llandovery formation of South Wales, while the fourth and fifth correspond to the Upper Llandovery and Tarannon.

(A) *Lower Birkhill*.—This includes the so-called zones of *Diplograptus acuminatus*, Nich., and *D. vesiculosus* of Dobbs Linn &c., and contains but few Graptolites in addition to those which give their names to the zones. *M. tenuis*, Portlock, and *M. attenuatus*, Hopk., are its only Monograptidæ, and are the first species of this family hitherto detected. The remaining fossils are Diplograptidæ of extended range.

(B) *Middle Birkhill*.—This division, which embraces the thick zone of *Monograptus gregarius*, Lapw., is most prolific in Rhabdophora, and is recognizable not only in the Moffat area, but also in Girvan, Ireland, and Sweden. In this zone the Diplograptidæ and Monograptidæ are tolerably equal in species and individuals. The species *D. vesiculosus*, Nich., and *D. physophora*, Nich., make here their final appearance. The genus *Rastrites* (Barr.) occurs for the first time; and the single species *Rastrites peregrinus* is remarkably prolific. Of the genus *Monograptus* species are abundant, but few are peculiar. Among the latter is the transitional form *M. triangulatus*, Harkn.

(C) *Upper Birkhill*.—This division, the most varied in its mineralogical character and its included species, has also the widest geographical extension. To it belong the graptoliferous shales of the so-called Lower Llandovery of Cardigan, recently examined by Prof. Keeping, and also the disputed graptolitic mudstones of the Coniston area of Westmoreland. Elsewhere its representatives are recognizable in Girvan, County Down, in the typical *Lobiferus*-beds of Scania, in the Alaunschiefer of Germany, and in the Colonies and the band *E e 1* of Bohemia.

In all these widely separated regions the fauna is most distinctly of the type of that of the Upper Birkhill shales. In this group, in the typical localities near Moffat, we recognize three fairly distinct zones, the lowest characterized by *Cephalograptus cometa*, Geinitz, and some survivals from the underlying *M.-gregarius* zone—and the upper distinguished by *Rastrites maximus*, Carr., and by a few species which become much more abundant in the overlying Gala beds.

Generally speaking, these Upper Birkhill beds, in the whole of their range from Cardigan through Northern and Central Europe, are particularized by the preponderance of Monograptidæ of the genera *Rastrites* and *Monograptus* (both of which probably attain their specific maximum upon this horizon), and by the exclusive presence of such forms as *Monograptus Hisingeri*, Carr. (*jaculum*), *M. intermedius*, Carr., *M. crenularis*, Lapw., and Diplograptidæ of the type of *Diplograptus Hughesi*, Nich., *Cephalograptus cometa*, Geinitz, &c.

A few of the commonest forms pass onwards into the strata of the succeeding Upper Valentian or Tarannon group. Of these the chief are *Climacograptus normalis*, Lapw., *Diplograptus palmeus*, Barr., *D. folium*, His., and some forms of *Monograptus Sedgwickii*, Portl.

Gala or Tarannon Group.

Mineralogically the distinction between the Gala group and the underlying Birkhill series is most marked; but palæontologically there is an insensible gradation from the one into the other. The Birkhill beds consist of black shales of no great vertical extent, while the Gala series is formed of grey conglomerates, flagstones, and shales of enormous collective thickness. It is more than doubtful, however, if the Gala group at all approaches the Birkhill beds in systematic importance. It must be looked upon at present as a transitional formation—its lower beds graduating zoologically into the inferior Birkhill beds, and its higher zones passing insensibly

TABLE VIII. Showing the Range of the Gala-Tarannon Rhabdophora.

	Tarannon Sh., Conway B., N. Wales.	South-east Scotland.		Girvan.	Sweden.	Bohemia.	Clinton Beds, N.E. America.							
		Gala Group (A).	Upper Gala (B).	Penkill Beds (A).	<i>Crossopodia</i> -Beds (A).	<i>Priodon</i> -Flags (B).	Tieveishilly (A), Ireland.	<i>M.-priodon</i> Schists (B).	Stygfor's Schists (A, B).	Thuringia (A, B), Germany.	Colonies.	Band Eel.	<i>Ampelite</i> -Limestone, France.	Clinton Beds, N.E. America.
MONOGRAPTIDÆ.														
<i>Rastrites distans</i> , <i>Lapw.</i>	*	*								*				
— <i>Linnæi</i> , <i>Barr.</i>										*			*	
— <i>fugax</i> , <i>Barr.</i>										*			*	
— <i>maximus</i> , <i>Barr.</i>		*		*						*			*	
<i>Monograptus Becki</i> , <i>Barr.</i>	*	*		*						*			*	
— <i>Barrandei</i> , <i>Suess?</i>			*				*	*		*			*	
— <i>bohemicus</i> †, <i>Barr.</i>										*	*		*	*
— <i>clintonensis</i> , <i>Hall</i>										*	*		*	*
— <i>colonus</i> , <i>Barr.</i>										*	*		*	*
— <i>concinnus</i> , <i>Lapw.</i>		*				*				*	*		*	*
— <i>crassus</i> , <i>Lapw.</i>	*	*			*					*			*	
— <i>crispus</i> , <i>Lapw.</i>	*	*					*	*					*	
— <i>exiguus</i> , <i>Nich.</i>	*	*			*								*	
— <i>Flemingii</i> , <i>Salt.</i>		*	*				*	*					*	
— <i>galaensis</i> , <i>Lapw.</i>	*	*	*		*	*	*			*			*	
— <i>Hisingeri</i> , <i>Carr.</i>		*	*	*			*	*		*			*	
— <i>leptotheca</i> , <i>Lapw.</i>				*					*				*	
— <i>lobiferus</i> , <i>M'Coy</i>								*		*			*	
— <i>Nilssoni</i> , <i>Barr.</i>								*		*		*	*	
— <i>nuntius</i> , <i>Barr.</i>								*		*		*	*	
— <i>priodon</i> , <i>Bronn</i>	*	*	*		*	*	*	*	*	*	*	*	*	*
— <i>proteus</i> , <i>Barr.</i>			*			*	*	*	*	*	*	*	*	*
— <i>riccartonensis</i> , <i>Lapw.</i>	*					*	*	*	*	*			*	
— <i>runcinatus</i> , <i>Lapw.</i>		*			*								*	
— <i>Salteri</i> , <i>Lapw.</i>			*	*	*					*	*		*	
— <i>Sedgwicki</i> , <i>Portl.</i>	*	*	*	*	*	*				*	*		*	
— <i>spiralis</i> , <i>Geinitz</i>		*				*	*	*	*	*	*		*	
— <i>turriculatus</i> , <i>Barr.</i>	*	*			*		*	*	*	*	*		*	
— <i>Ræmeri</i> , <i>Barr.</i>							*	*	*	*	*		*	*
— <i>vomerinus</i> , <i>Nich.</i>			*			*		*					*	*
<i>Cyrtograptus Grayæ</i> , <i>Lapw.</i>		*				*								*
DIPLOGRAPTIDÆ.														
<i>Diplograptus folium</i> , <i>His.</i>	*	*		*					*	*	*		*	
— <i>palmeus</i> , <i>Barr.</i>		*		*	*				*	*	*		*	
— <i>tamariscus</i> , <i>Nich.</i>		*		*	*				*	*	*		*	
<i>Climacograptus normalis</i> , <i>Lpw.</i> , var.	*	*		*	*				*	*	*		*	
— <i>tectus</i> , <i>Barr.</i> , var.											*		*	
<i>Retiolites Geinitzianus</i> , <i>Barr.</i>	*		*			*	*					*	*	*
— <i>obesus</i> , <i>Lapw.</i> , var.		*											*	*
— <i>venosus</i> , <i>Hall</i>													*	*

† The species printed in italics in this table do not occur upon these horizons in Britain, and are possibly erroneously identified from the corresponding European zones.

upwards into the Riccarton Flags, which are the South-Scottish equivalents of the Wenlock beds of Siluria.

This also appears to be the general zoological character of the Tarannon shale of Wales and the north of England, which occupies the systematic place of the Gala group, to which, however, it is vastly inferior in vertical thickness and in the richness and variety of its Graptolite fauna.

In the Gala beds of the south of Scotland we recognize at present two main divisions. In the Lower Gala alone do we meet with the survivals from the Birkhill fauna; but these are here associated with the typical Gala species, *Monograptus exiguus*, Nich., *M. galaensis*, Lapw.—together with *M. priodon*, Bronn, which ranges upwards from this horizon into the Wenlock shale. In the Upper Gala the fauna gives many indications of the gradual change into that of the Salopian type—*Retiolites Geinitzianus*, Barr., *Monograptus riccartonensis*, and other Wenlock forms being frequently met with. Here we meet for the first time with the genus *Cyrto-graptus* of Carruthers. The genus *Rastrites*, however, is already extinct; and all the Diplograptidæ have disappeared, with the exception of an occasional form in the basal beds, minute and hardly capable of specific identification.

The graptolitiferous Tarannon shales of Conway yield a fauna corresponding to that of the earlier portion of the Gala beds; and the few forms hitherto collected from the Gala shales (Knock beds) of Westmoreland and the Tieveshilly shales of North-eastern Ireland afford unmistakable indications of the presence in these localities of a corresponding assemblage of forms.

The predominant and characteristic fossil of the Lower Gala subformation is *Monograptus exiguus*, Nich., which is as yet unknown outside the limits of the Lower Gala-Tarannon series.

Salopian or Wenlock-Ludlow Formation.

In the Valentian or Llandovery-Tarannon formation, as we have seen, the Diplograptidæ, so prevalent in its earlier strata, succumb before the swift increase of the Monograptidæ, till finally in the highest Tarannon beds they have dwindled away to an occasional diminutive form of *Diplograptus* only. In the overlying Salopian beds even these degenerate forms appear to be wanting; and in the lower divisions of the Wenlock shales of Britain the numerous Monograptidæ are accompanied only by the single diprionidian species *Retiolites Geinitzianus*, Barr. This, again, is unknown in the highest beds of the

TABLE IX. Showing the Range of the Salopian Rhabdophora.

	Zone of <i>Cyrtograptus Murchisoni</i> .				Wenlock Shales.								Lower Ludlow.	
	Britain.													
					Wales.				Scotland.					
	Builth.	N. Wales.	Lake District.	<i>Retiolites</i> -Beds, Scania.	Builth.	N. Wales.	Lake District.	Riccarton Beds.	Pentland Hills.	Norway.	Zone of <i>M. testis</i> &c., Scania.	Neffez, France.	E e 2, Bohemia.	M.-colonus Zone, Scania.
MONOGRAPTIDÆ.														
<i>Monograptus bohemicus</i> , Barr.	..	..	..	..	..	..	*	..	..	..	..	*	*	*
— <i>chimæra</i> , Barr.	..	..	..	..	..	..	*	..	..	..	..	*	*	*
— <i>Flemingii</i> , Salt.	..	..	*	..	..	..	*	*	..	..	..	*	*	*
— <i>colonus</i> , Barr. (?)	..	..	..	..	..	..	*	..	*	*	*	..	*	*
— <i>basilicus</i> , Lapw.	*	..	*	..	..	..	..	..	..	..	..	..	..	..
— <i>leintwardinensis</i> , Hopk.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— <i>M'Coyii</i> , Lapw.	..	..	..	..	..	..	*	..	..	..	..	..	..	..
— <i>Nilssoni</i> , Barr.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— <i>nudus</i> , Lapw., var.	..	..	*	*	..	..	..	*	..	..	..	..	..	..
— <i>minor</i> , M'Coy	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— <i>priodon</i> , Bronn	*	*	*	*	*	*	*	*	*	*	*	*	*	*
— <i>Rœmeri</i> , Barr.	..	..	..	..	..	..	..	..	..	..	..	*	*	*
— <i>Salweyi</i> , Hopk.	..	..	..	..	..	..	..	..	..	..	..	..	*	*
— <i>scanicus</i> , Tullb.	..	..	..	..	..	..	..	..	..	..	..	..	*	*
— <i>vomerinus</i> , Nich.	*	*	*	*	*	*	*	*	*	*	*	..	..	..
— <i>riccartonensis</i> , Lapw.	*	..	*	*	..	..	..	*	..	..	*	..	..	..
— <i>testis</i> , Barr.	..	..	..	..	..	..	..	..	..	..	*	..	..	..
<i>Cyrtograptus Carruthersi</i> , Lapw.	..	..	..	..	..	..	*	*	*	..	..	..	..	..
— <i>Linnarssoni</i> , Lapw.	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— <i>Murchisoni</i> , Carr.	*	*	*	*	..	..	..	..	..	..	..	..	..	..
RETIOLITIDÆ.														
<i>Retiolites Geinitzianus</i> , Barr.	*	*	*	*	..	..	..	?	*	*	..	..	..	..

Wenlock, or in the so-called Lower Ludlow shales, where Monograptidæ alone have hitherto been detected. The members of this family are tolerably abundant in the lower zones of the Wenlock; but specifically they are far less numerous than in the populous Birkhill shales of the Lower-Valentian era. In the Lower Ludlow, Monograptidæ are not uncommon upon certain horizons; but the species are few and of few types. Above this subformation the sandy strata of the Downtonian formation suddenly set in; and beyond the occa-

sional recognition of a fragmentary specimen of *Rhabdophora* in these deposits incapable of specific identification, nothing is known of their further existence.

In the great mudstone series of the Salopian of Siluria, at least two fairly distinct zones are at present recognizable. The base of the Wenlock from Llangadock to Bala and Glyn Ceriog, as well as in the Lake district itself, is formed by a series of dark shales and flags marked by the presence of *Cyrtograptus Murchisoni*, Carr. It is accompanied by the other forms enumerated under this head in the accompanying Table, some being survivals from the Tarannon fauna, and others strictly peculiar to the Wenlock shales. The same zone is recognizable in Scania, occupying a similar stratigraphical place and yielding a corresponding Graptolite fauna.

In the main mass of the Wenlock shales *Cyrtograptus Linnarssoni*, Lapw., is the most conspicuous form near Builth. Of the fossils peculiar to higher horizons we as yet know little; but it may be expected that we shall in the future meet here with the zone of *M. testis*, Barrande, which has hitherto remained undiscovered in Britain, but has a wide geographical range on the European continent.

The most abundant forms of Wenlock age in Britain are:—*M. vomerinus*, Nich., which is ubiquitous in its distribution; *M. riccartonensis*, a most prolific Scotch species; and *M. priodon*, Bronn, which does not appear to survive into the later strata of the Lower Ludlow.

Lower Ludlow Beds.

It is certain that we have yet much to learn with respect to the *Rhabdophora* of the Upper Wenlock beds; for none of the forms enumerated above appear to survive into the Lower Ludlow formation. In certain localities, however, these Lower Ludlow beds are prolific in Graptolites, especially *M. Salweyi*, Hopk., *M. leintwardinensis*, Hopk., *M. Nilssoni*, Barr., *M. bohemicus*, Barr., *M. scanicus*, Tullberg, many of which are present also in the highest zones of the graptoliferous rocks of Scania and in corresponding strata in Bohemia and France.

[To be continued.]

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