Fig. 24 *a, b. T. Menardi*, Lam. A *ventral* valve, from the pebble-bed of Godalming.

25. *T. Menardi*. Dorsal valve, from the Bargate-stone of Guildford.

26, 27. *Terebratulina striata*, Wahl. Single valves, from the pebble-bed of Godalming.

(The vertical lines indicate the length of the specimens.)

PLATE XII.

(All the figures in this Plate are represented of the natural size.)

Figs. 1 *a, b, c, d*, & 2 *a, b. Terebratula extensa*, sp. nov. Specimens from the pebble-bed at Tewsley, near Godalming.

Fig. 3. *T. extensa*. A *dorsal* valve, on which the central, longitudinal depression is strongly marked.

4. *T. extensa*. Portion of a *ventral* valve, showing the form of beak and its deltidium.

5 *a, b, c, d. T. Boubei* (?), D'Archiac. A specimen from Folkestone.

6. *T. Boubei* (?). From the Sponge-gravel of Farringdon.

7 *a, b, c. T. Boubei* (?). From the pebble-bed at Tewsley, near Godalming.

8 *a, b, c. T. Tornacensis*, D'Archiac, var. Dorsal valve, from the pebble-bed near Guildford.

9. *T. Tornacensis*. Ventral valve from Godalming.

10 *a, b. T. Robertoni* (?), D'Archiac. From the pebble-bed at Hurtmore, near Godalming.

11 *a, b. T. Robertoni* (?). From the pebble-bed near Guildford.

12 *a, b, c. Waldheimia Moutoniana*, D'Orb. A specimen from the pebble-bed at Shanklin, Isle of Wight.

13. *W. Moutoniana*. A specimen from Shanklin, with part of the dorsal valve removed, showing a portion of the elongated loop.

14 *a, b, c. W. Moutoniana*. From the pebble-bed of Godalming.

15 *a, b. Terebratula depressa*, Lam. A fine specimen from the Lower Greensand of Shanklin, Isle of Wight.

II. OUTLINE OF THE RHÆTIC FORMATION IN WEST AND CENTRAL SOMERSET. By W. BOYD DAWKINS, B.A. Oxon., F.G.S.; of the Geological Survey of Great Britain.

CONTENTS:—I. Introduction; II. White Lias, or Upper Rhætic; III. *Avicula-contorta*-series, or Middle Rhætic; IV. Lower Rhætic (Marls).

I. **T**HE identification of the Rhætic Formation in Britain, previously discovered to be intercalated between the Keuper Marls and Lower Lias Shales in Germany, we owe to the labours of Dr. Wright, F.G.S., and Mr. Charles Moore, F.G.S. In the year 1860, the former published an account of the strata beneath the Lias, characterized by the occurrence of *Avicula contorta*; the latter, in the following year, showing in a most valuable paper the true relation of the sandstones, shales, and limestones to the White Lias above and the Keuper below, added upwards of twenty-eight new species to the list of British Fossils. The White Lias, which Dr. Wright incorporated with the group of beds characterized by *Ammonites planorbis*, Mr. Moore considered to belong to, and to constitute an upper member of, the Rhætic Formation. Lastly, in 1861, after a

careful examination of these beds in the West of England, I was able to trace the downward extension of the formation into the Grey Marls, until that time classed with the Keuper. My reason for treating, in the pages of this Magazine, of subject-matter that has already been embodied in a paper just published in the Quart. Journ. Geological Society, vol. xx. p. 396, is that new evidence has been adduced since the latter was written, inclining me to modify some of the views therein expressed. I purpose, therefore, to treat of the beds in question in three groups:—first, the White Lias or Upper Rhætic; secondly, the *Avicula-contorta*-series or Middle Rhætic; and lastly, the Grey and Black Marls and Marlstones up to the present time classed with the Keuper Marls, or the Lower Rhætic.

II. *The White Lias*.—Immediately underlying the dark-blue shales and thinly bedded limestones of the *Ammonites-planorbis*-zone, which in the Poulden Hills, and near the villages of Butleigh, King-weston, Charlton-Adam, Kingsdon, Long-Sutton, and West Hatch are characterized by *Myacites unionoides*, occurs the White Lias, composed of a series of earthy limestones, thinly bedded, and separated from each other by loose earthy marl. Sometimes the limestones are very hard, and of a pinkish tinge, as at West Hatch, where also some of the layers are very much water-worn, and bored by *Pholades*. More generally, however, the beds vary from a milk-white to a dark grey colour. The following section of the White Lias at Long-Sutton is a fair example of the beds and their fossils in the West of England, and is important as showing the total thickness of the White Lias, from the *Ammonites-planorbis*-shales above, to the *Avicula-contorta*-series below:—

- 7 inch. Soft grey Lias, earthy.
- 13 „ White marly earth.
- 28 „ Soft grey earthy Lias: *Modiola minima*, *Lima pectinoides*.
- 16 „ Two layers of earthy grey Lias.
- 4 „ Grey shale.
- 9 „ Hard grey Lias.
- 24 „ Six layers of earthy marly Lias.
- 12 „ Hard grey Lias: casts of Corals, *Cladyophyllia* (?).
- 18 „ Six layers of soft earthy Lias: *Modiola minima*, *Lima punctata*.
- 4 „ Hard grey Lias, with worn surface; evidently an old sea-bottom. It burns into 'White Lime.'
- 5 „ Earthy grey Marl: *Cardium Rhæticum*, *Modiola minima*, *Pleurophorus*.
- 56 „ Five layers of earthy grey Lias, without shale. It burns into good lime.

In thickness the White Lias varies considerably, even over small areas, measuring 9 feet at Beer-Crowcombe, and 32 feet at Saltford, near Bath. Its average thickness in West and Central Somerset is 15 feet.

Palæontologically, it is remarkable for the rarity of specific forms; and, so far as I know, it does not possess any one species peculiar to itself, excepting, perhaps, a small Coral (*Cladyophyllia*?) found at Long-Sutton (see preceding section), and also near Theale. In the absence of *Ammonites*, it contrasts with the beds above; in the absence of *Vertebrates*, with those above and below. In the paper before alluded to, I was inclined to consider it the passage-

beds of the Lower Lias, its fossils, so far as they had at that time been made out, being as much Liassic as Rhætic; for if *Monotis decussata*, *Cardium Rhæticum*, *Pleurophorus* (sp.), and *Ostrea interstriata* bound it to the latter formation, so also did *Modiola Hillana*, *Pecten textorius*, *Pholadomya glabra*, and *Lima punctata* bind it to the former. In the conflicting palæontological evidence, therefore, as to true classification, I appealed to its lithology; and, as it contrasts strongly with the beds below in the absence of arenaceous deposits, and was akin to those above in the large development of the calcareous element, I classed it with the latter. Since that time, however, additional palæontological evidence has been adduced, that turns the scale the other way. Mr. R. Tate, F.G.S., in a list of fossils from the White Lias of the neighbourhood of Belfast (Quart. Journ. Geol. Soc. vol. xx. p. 109), adds to its fauna *Axinus cloacinus*, Quenstedt, *A. concentricus* (?), Moore, and an *Arca* closely allied to *A. Lycetti*, all of which, up to that time, had been found only in the *Avicula-contorta*-series below. It is therefore evident, that, while these beds, by the presence of a mixed molluscan fauna are passage-beds, they are more akin to the Rhætic formation than to the Liassic; the lithological characteristics derived from varying depth of sea, proximity to land, and the like, being of far less value in classification than the evidence afforded by palæontology. It is for this reason, therefore, that I consider the White Lias to constitute the Upper Rhætic group. The great breaks in the succession of life, both above and below, prove that great intervals elapsed between the deposition of the *Avicula-contorta*-series, below, and the White Lias, as also between the latter and the *Ammonites-planorbis*-zone.

III. *Avicula-contorta*-group, or *Middle Rhætic*.—This is composed of a series of dark and grey marls, thinly bedded, micaceous, and pyritous sandstones, and dark-grey or blue limestones. Sometimes there is a layer of conglomerate, as in a section near Frome, described by Mr. C. Moore, F.G.S. (Quart. Journ. Geol. Soc., vol. xvii. p. 497). Very generally the beds are charged with a fibrous carbonate of lime, strongly resembling gypsum, and are more or less micaceous. Throughout the series, traces of animal life are remarkably abundant; and usually at the base there is a *Bone-bed*, made up of the remains of Fishes and Saurians, and more or less conglomeratic. This bed, at Diegerloch, near Stuttgart, yielded teeth of *Microlestes* to Professor Plieninger. From this also, or from the dark shale above, which contains similar organic remains, the mammalian teeth found by the industry of Mr. C. Moore, in a fissure of the Carboniferous Limestone, near Frome, were probably derived, the stratum in which they were originally deposited having been broken up and washed into the fissure, together with the débris of other and younger rocks.

Besides the Bone-bed universally present at the base of the *Avicula-contorta*-series, there are two more, on the Watchet shore, in the middle and upper parts. Two or three beds of dark impure limestone, charged with fibrous carbonate of lime, and composed in

great part of crushed *Pecten Valoniensis*, DeFrance, appearing at Uphill, Watchet, and Stoke-Courcy, characterize the upper portion of the series. The fact, that the pebbles included in the conglomeratic bone-bed at the base are rounded fragments of the subjacent rock, intimates an interval of greater or less length, during which the subjacent sands became indurated into sandstone, and so elevated as to be exposed to the violence of the waves. Quartzose pebbles also prove that the Mid-Rhætic sea beat against cliffs of Devonian age. In thickness the *Avicula-contorta*-series varies from eleven feet, at Beer-Crowcombe, to twenty-five feet at Saltford. Its sandstones, shales, and earthy limestones prove it to have been deposited in comparatively shallow water, and not very far from land.

IV. *The Lower Rhætic Marls and Marlstones*.—These are generally unfossiliferous; and, from their conformity with, and gradual passage into the Red Marls of the Keuper, were formerly considered to belong to the latter. The Marlstones are hard, grey, and slightly calcareous; and are at some places intercalated with a coal-black shale, as on the Watchet shore. The upper Marlstones are laminated, ripple-marked, and traversed by the borings of Annelids. Sometimes both marls and marlstones are highly gypseous. I have included both in the Rhætic Formation on the evidence of the fossils found some 10 feet below the Bone-bed to the west of Watchet. They consist of *Modiola minima*, *Myacites striato-granulata*, *Gervillia precursor*, *Pecten Valoniensis*, *Pullastra arenicola*, *Cardium Rhæticum*, *Saurichthys apicalis*, *Gyrolepis Alberti*, *G. tenuistriatus*, *Acrodus minimus*, and *Sargodon Tomicus*, besides many forms too fragmentary to be identified. Here I obtained also a tooth of the oldest British mammal yet found in a stratified deposit. It is allied to the Kangaroo-rat, and is described in the paper before alluded to, under the provisional name of *Hypsiprymnopsis Rhæticus*. This assemblage of species proves beyond all doubt the Rhætic age of the rocks in which they occur; and, as the latter differ in no respect from the grey unfossiliferous marls and marlstones lying beneath, save in the accidental preservation of the fossils, it is a fair inference that both fossiliferous and unfossiliferous belong to the same group. Lithologically, in colour and texture, and in the arenaceous conditions of deposit, they are identical. Considering, therefore, the preservation or non-preservation of the fossils a mere accident, I propose to include the grey marls, marlstones, and black shales, down to the point where the Red Marls begin to appear, in the Rhætic Formation, whether they be fossiliferous or not. The thickness of the rocks so defined, from the Bone-bed above downwards to the first layer of Red Marl, on the east side of Watchet harbour, is 53 feet, and at Saltford 30 feet. Further down, beneath alternations of Red and Grey Marls and Marlstones, that prove the gradual passage of the Keuper into the Lower Rhætic series, is the deep-red marl so characteristic of the former.

A tabular list of Rhætic fossils is given at p. 406 of the paper alluded to above.