$$OH + H_2 \rightarrow H_2O + H$$
$$OH + NO_2 \rightarrow HNO_3$$
$$OH + O_3 \rightarrow HO_2 + O_2$$
$$HO_2 + NO \rightarrow NO_2 + OH$$
$$HO_2 + O_3 \rightarrow 2O_2 + OH$$
$$NO_2 + h\nu(\lambda < 420\ nm) \rightarrow NO + O(^3P)$$
$$O(^3P) + O_2 + M \rightarrow O_3 + M$$
$$O_3 + NO \rightarrow NO_2 + O_2$$

Presence of other NMHC molecules will remove NO_x through similar oxidation reactions, eg:

$$RH + OH \rightarrow R. + H_2O$$

(where $R.$ is the alkane radical other than CH_3)

$$R. + O_2 + M \rightarrow RO_2 + M$$
$$RO_2 + NO \rightarrow R.O. + NO_2$$
$$NO_2 + O_3 \rightarrow NO_3 + O_2$$
$$NO_3 + NO_2 \rightarrow N_2O_5$$
$$N_2O_5 + H_2O \rightarrow 2HNO_3$$

Hence production or destruction of ozone is the outcome of a complex set of chemical reactions. Ozone is produced due to oxidation of methane provided NO_x is present in right proportion. For low or very high values of NO_x, ozone in the troposphere will be lost.

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RESEARCH COMMUNICATIONS

Late and terminal Cretaceous foraminiferal assemblages from Ukhrul, Mélange zone, Manipur

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Foraminiferal assemblages from exotic blocks in the melange zone of Ukhrul, Manipur provide significant data on deep oceanic sediments in Late and Terminal Cretaceous and their subsequent obduction along the eastern margin of the Indian Plate. Using a modified version of copper sulphate and acetic acid technique, beautifully preserved and biostratigraphically important planktonic foraminifera from two closely-spaced localities; Hundung North and Mova have been recovered. The age of the Ukhrul limestone helps to determine the basinal conditions and timing of obduction on a regional basis.

SEVERAL fossil-bearing localities have been recorded in recent years in the Mélange zone of Naga–Manipur Ophiolite belt. Assemblages are suggestive of Maestrichtian, Palaeocene and Eocene ages[1]. Using a modified version of a maceration technique developed by Zolnaj[2], foraminiferal assemblages were recovered from limestone bodies ranging in thickness from a few metres to several metres, found as mélange in the upper arenaceous part of the Disang Group of Middle to Upper Eocene[3,4] age. The fossil biotas of these limestone blocks record the turbulent history of the obduction of oceanic crust and deep sea sediments on to the advancing Indian plate along its eastern margin. The foraminiferal assemblages described in this paper help to establish a Late Campanian and Late Maestrichtian for the sampled sections and hold out promise for locating Cretaceous–Tertiary boundary events.

Recent sampling from two closely-spaced localities (Figure 1)—Hundung North and Mova resulted in the recovery of beautifully preserved foraminiferal assemblages. The assemblage at Hundung North comes from a hard brownish grey bio-micrite with various cross-cutting joint planes filled with calcite while the assemblage at Mova comes from a hard whitish-grey bio-micrite. These horizons are separated by a sequence of shales and siltstone, and the exact inter-relationship between the two is not obvious at present.

Microfossils recovered from both localities include planktonic and benthonic foraminifera, radiolaria, a few ostracods and placoid scales of shark. Some of the planktonic foraminifera have been identified and studied under microscope (Table 1). Presence of *Globotruncanita calcarata, G. subspinosa* and *Globotruncana linneiana* in the Hundung North sample undoubtedly indicates Late Campanian age for the Hundung North sample whereas the presence of *Abathomphalus mayaroensis, Rosita contusa* and *Globotruncanella petalloidea* in the Mova sample indicates a Late Maestrichtian age for the Mova sample. Only two most important

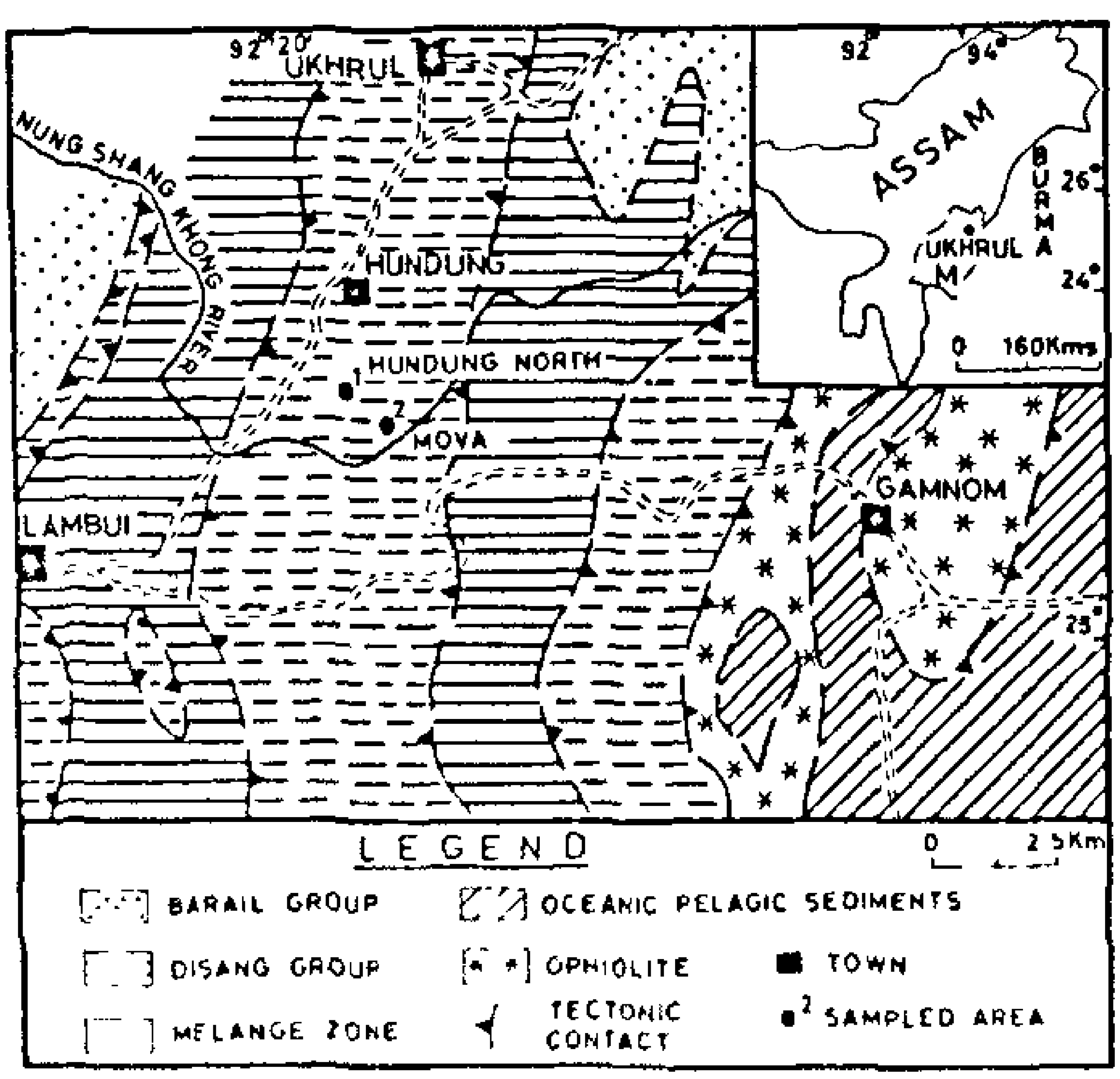

Figure 1. Geological and location map (Modified after S. A. Khan[4]. Barail Group (Upper Eocene to Oligocene), Disang Group (Upper Cretaceous to Middle Eocene), Melange Zone (Cretaceous to Eocene), Oceanic Pelagic Sediments (Paleocene to Middle Eocene), Ophiolite (Maestrichtian and Older). M – Manipur. Loc. 1 – Hundung North, Loc. 2 – Mova and 1 km downstream

Table 1. Planktonic foraminiferal assemblages fro Ukhrul Limestone

Foraminifera	Hundung North	Mova
Family: Globotruncanidae		
Globotruncana linneiana P/VPL-S3-5-7	p	p
G. mariei P/VPL-S8-13,14	p	p
G. bulloids P/VPL-S9-1,2	p	p
G. arca P/VPL-S6-1	p	p
G. aegyptiaca P/VPL-S8-4-6	a	p
G. falsostuarti P/VPL-S6-6,7	p	p
G. ventricosa P/VPL-S11-3-5	p	a
G. orientalis P/VPL-S11-1,2	p	a
Globotruncanita stuarti P/VPL-S6-8,9	p	p
G. stuartiformis P/VPL-S6-19,20	p	p
G. pettersi P/VPL-S8-10-12	a	p
G. conica P/VPL-S8-8,9	a	p
G. calcarata P/VPL-S3-1-3	p	a
G. subspinosa P/VPL-S9-8-10	p	a
G. elevata P/VPL-S9-5	p	a
Rosita contusa P/VPL-S2-6-8	a	p
R. fornicata P/VPL-S9-3,4	p	a
R. patelliformis P/VPL-S6-5-7	p	p
Abathomphalus mayaroensis P/VPL-S12-1	a	p
A. intermedius P/VPL-S2-20	a	p
Gansserina gansseri P/VPL-S4-5,6	a	p
G. wiedenmayeri P/VPL-S8-1-3	a	p
Globotruncanella petalloidea P/VPL-S5-1,2	a	p
Family: Heterohelicidae		
Racemiguembelina fructicosa P/VPL-S8-7	a	p
Heterohelix globulosa P/VPL-S2-12-14	p	a
H. striata P/VPL-S2-15-17	p	p
Pseudoguembelina costulata P/VPL-S2-18,19	p	p
Pseudotextularia elegans P/VPL-S2-3-5	p	p

p = Present, a = Absent.

taxa have been illustrated for each sample (Figure 2). Assemblages from both these localities, compounded with very fine nature of the grains, indicate a deep water oceanic depositional condition and a slow rate of net sediment accumulation.

The present study holds out great promise in elucidating basinal characteristics and biotas at the end of the Cretaceous and in setting constraints for the obduction process in previously geologically neglected area of Manipur. The previous systematic study in the area[3] did not give a precise age for the oldest exotics nor did it illustrate the specific characters of the assemblages with clarity. The present paper suggests Late Campanian age for the oldest exotic block, continued deep oceanic sedimentation at least to the Lower Eocene[3], reasonably good chances of locating Cretaceous Tertiary boundary events in the Mova locality and a diversified fossil association comprising radiolarite, nannoplanktone, placoid scales of shark, planktonic and benthonic foraminifera. More detailed studies on individual limestone block in the Naga Manipur ophiolite belt could determine the time of suturing of eastern India and southern China blocks on a regional scale.

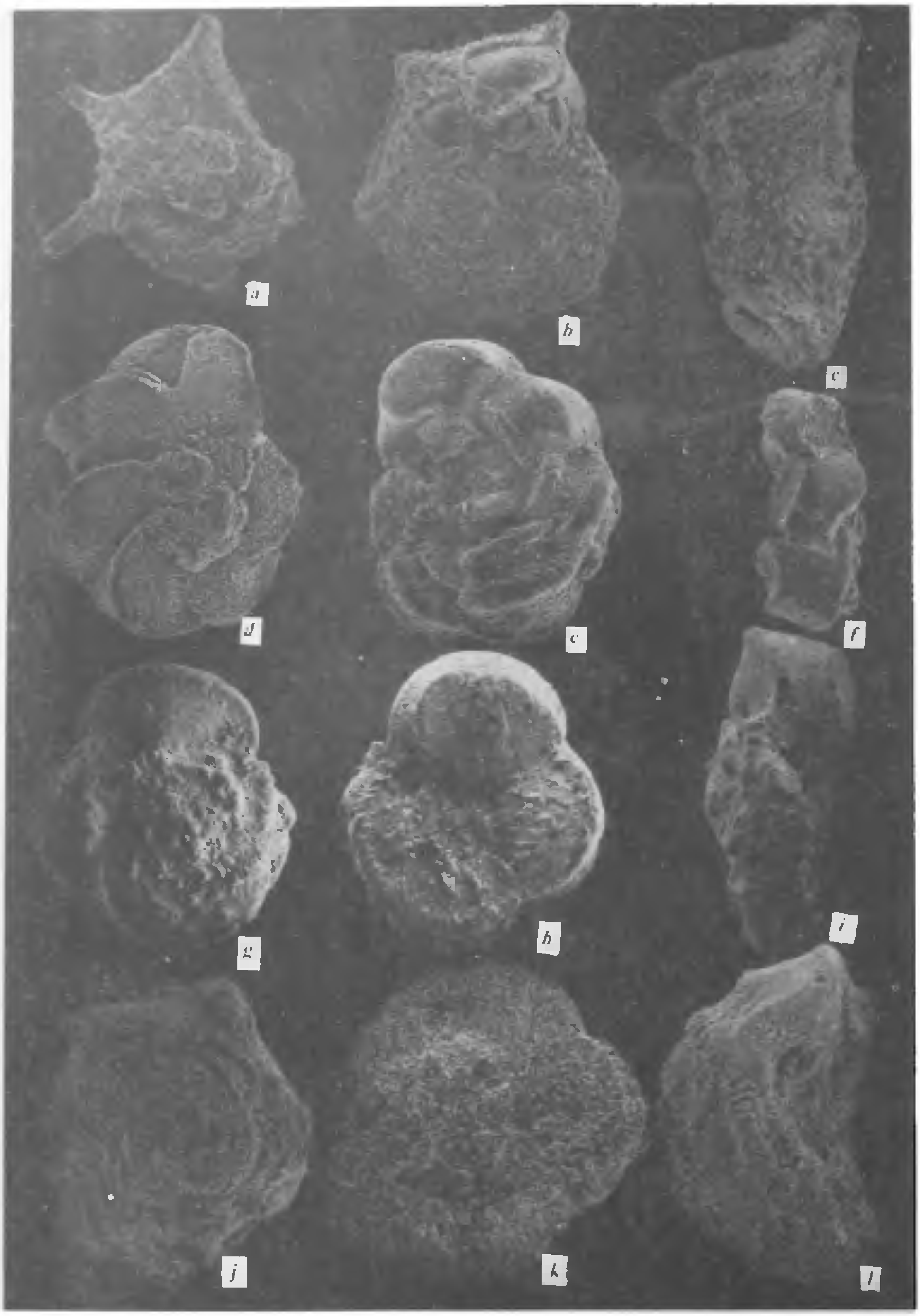

Figure 2.

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Rapid generation of probe for a ss DNA plant virus directly from total DNA of infected tissue

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A quick procedure for generating radiolabelled probe for ss DNA viruses using total DNA from infected leaves has been described. The method works well for detection of individual geminiviruses and can be used for establishing relationships amongst different geminiviruses affecting plants.

SINGLE-stranded DNA (ss DNA) containing plant viruses which belong to geminivirus group are often difficult to isolate due to their fragile nature and low concentration in plant tissue[1]. In such cases, generation of immunoprobes or nucleic acid probes poses a problem. We have prepared a viral genome-specific radiolabelled probe directly from the total DNA obtained from leaves of *Acalypha indica* affected by a putative geminivirus[2].

The genome of known geminiviruses is an ss DNA. The infected tissue also contains several replicative double-stranded forms (ds DNA), one of which is covalently closed in only one strand[3–6]. The basis of our approach was that ss DNA present in the infected tissue will be specifically labelled by primer extension if the total DNA from infected leaves is not melted for strand separation prior to labelling. Moreover, one of the replicative forms which has discontinuity in one strand will also be labelled simultaneously while most of the ds DNA of the host would not.

Total DNA (nucleic acids were earlier treated with excess RNAse) from plants was prepared by a method described earlier, with minor modifications[6]. Labelling by primer extension was done using random primers (Pharmacia, Sweden), AMV reverse transcriptase (Gibco BRL, USA) and total DNA isolated from leaves. Briefly the 50 μl reaction mixture contained 5 μg of unheated

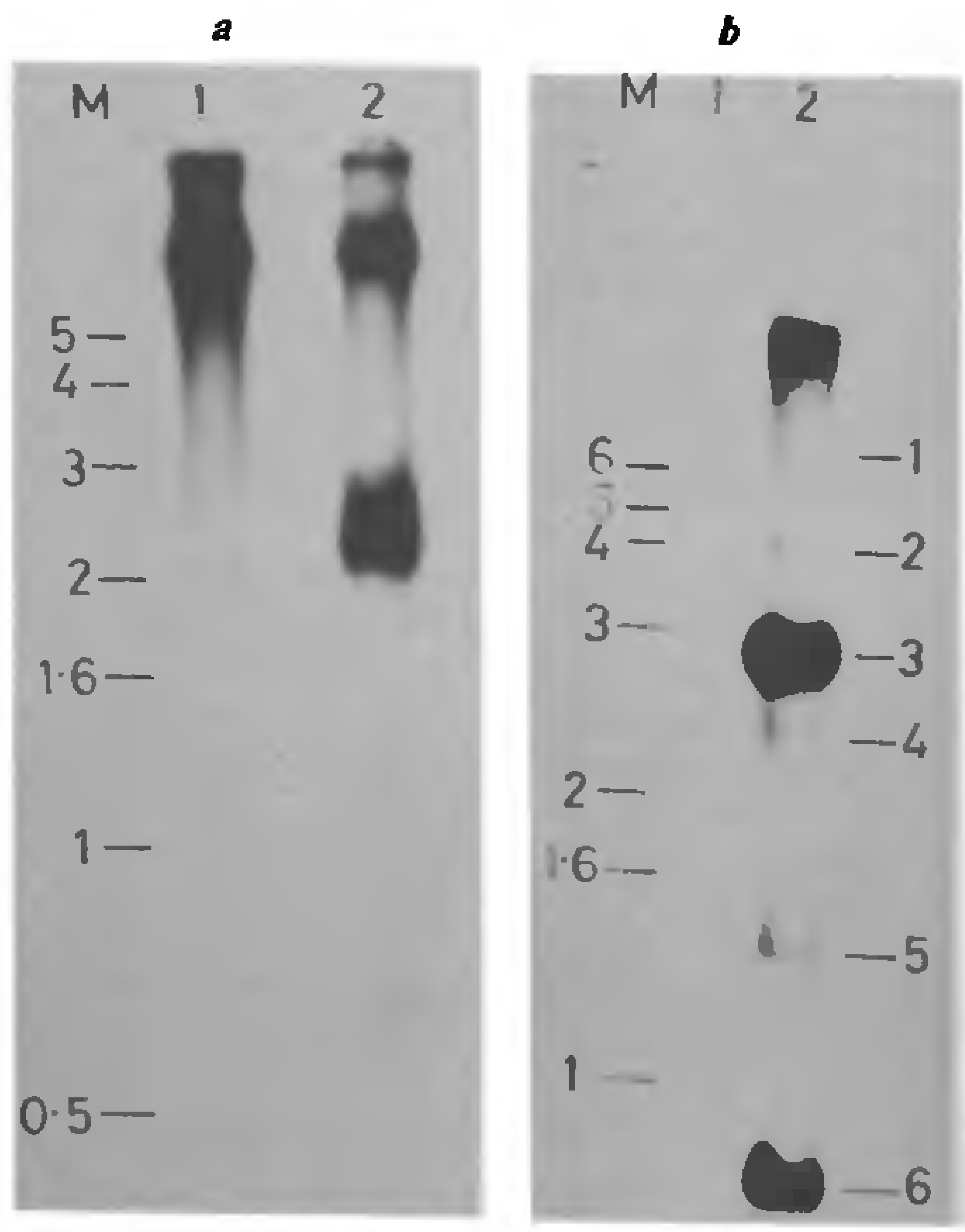

Figure 1. ***a***, Autoradiograph showing separation of labelled DNA molecules generated from total healthy leaf DNA (HL-DNA) and total diseased leaf DNA (DL-DNA) on 1.2% agarose gel. ***b***, HL-DNA and DL-DNA were electrophoresed on 1.2% agarose gel, transferred on NC membrane and probed with the product of DL-DNA obtained by primer extension using random primers, reverse transcriptase, $\alpha(-^{32}P)$ dGTP.
M = Position of BRL 1kb ladder, 1 = HL-DNA; 2 = DL-DNA.

Figure 2. Scanning electron micrographs of planktonic foraminifera. *a* to *f* from Hundung North and *g* to *l* from Mova. ***a***, *Globotruncanita calcarata* (spiral view, × 170, P/VPL-S3-1), ***b***, *G. calcarata* (umbilical view, × 148, P/VPL-S3-2), ***c***, *G. calcarata* (keel view, × 97, P/VPL-S3-3); ***d***, *Globotruncana linneiana* (spiral view, × 115, P/VPL-S3-5), ***e***, *G. linneiana* (umbilical view, × 101, P/VPL-S3-6); ***f***, *G. linneiana* (keel view, × 129, P/VPL-S3-7), ***g***, *Abathomphalus mayaroensis* (spiral view, × 114, P/VPL-S12-1), ***h***, *A. mayaroensis* (umbilical view, × 117, P/VPL-S12-1), ***i***, *A. mayaroensis* (keel view, × 119, P/VPL-S12-1), ***j***, *Rosita contusa* (spiral view, × 121, P/VPL-S4-1), ***k***, *R. contusa* (umbilical view, × 139, P/VPL-S4-2), ***l***, *R. contusa* (keel view, × 122, P/VPL-S4-3)