

cuous and rather consistent increase in the depth of the trough (N_c/N_H), either during the same night or the next night of the sudden commencement of the storm with a similar pattern of enhancement in the occurrence of spread-F at Hobart (storms 2-6 of Table I). The observed increase in the occurrence of the spread-F at Hobart after the initiation of the storm (storms 2-7 of Table I) is in agreement with the findings of the earlier statistical studies⁶⁻⁸ that enhanced geomagnetic activity lead to an increase in (spread-F occurrence at midlatitudes with a lag of 0-2 days. It may also be seen from Figs. 1 and 2 that the occurrence of spread-F at Hobart during storm conditions is usually associated with relatively high values of N_c/N_H (1.5 and above). However, there is no one-to-one association between the occurrence of spread-F at Hobart and relatively high values of N_c/N_H when examined on a hour to hour basis. A good example of this is the behaviour during the night of 20-21 December 1971 (Storm 7).

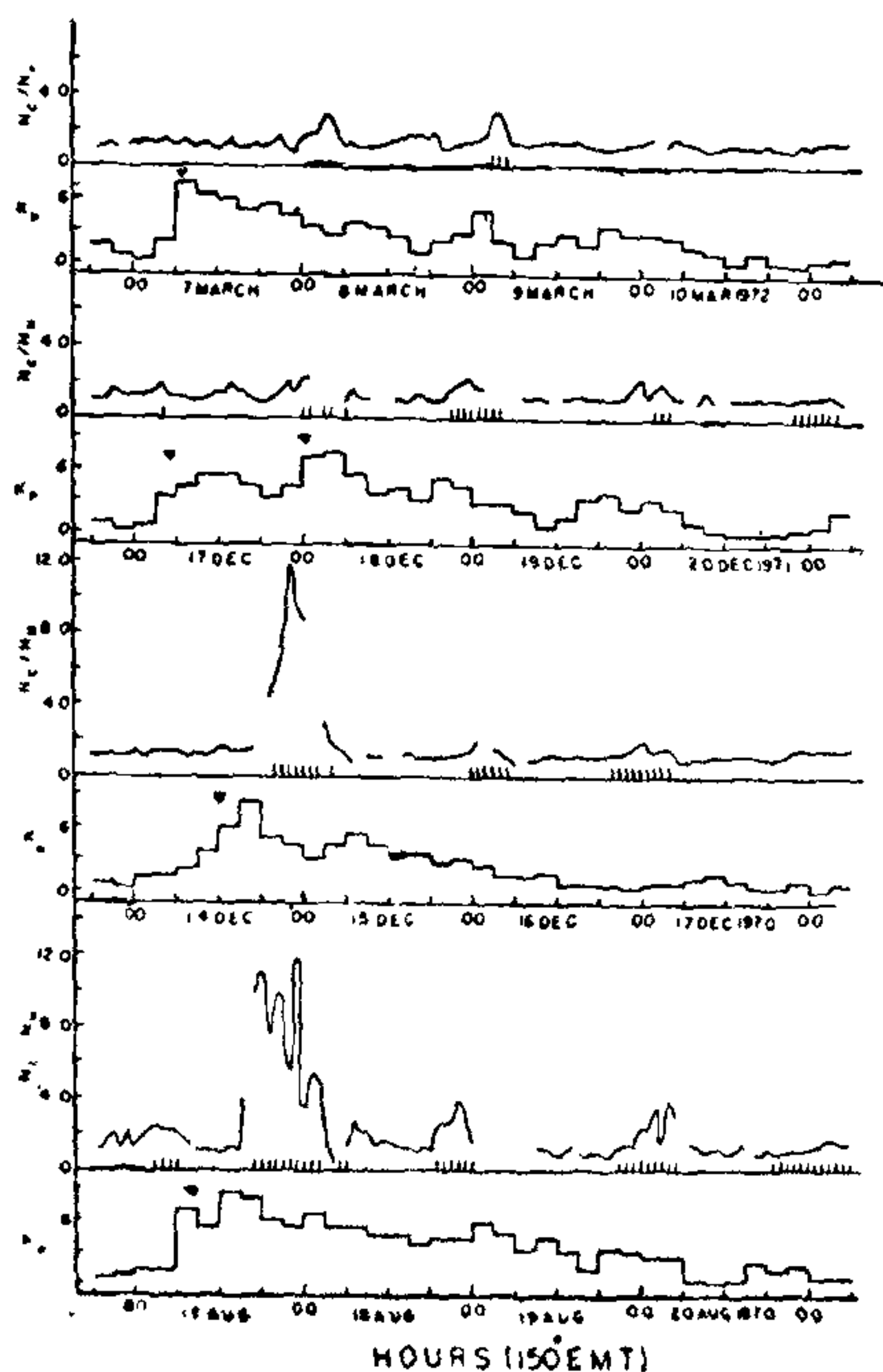


FIG. 2. Same as Fig. 1 for the storms of 17 August 1970; 14 December 1970; 17 December 1971 and 7 March 1972.

The above observations suggest that one of the causes (if not the cause) of the occurrence of spread-F at higher midlatitudes is the formation of the midlatitude ionospheric trough and the possible multiple

reflections from the steep ionization gradients at the edges of the trough, lending further support to the work of Nichol⁵ and the author.⁶ The present study also suggests the need for further studies with more detailed information on the trough characteristics (using either foF2 or total electron content (N_T) data from a close network of stations around the trough zone) and the spread-F characteristics (using actual ionogram data to infer the type of spread-F configuration, extent of spread.....etc.) to enable a better understanding of the role of the formation of the midlatitude ionospheric trough as a cause of spread-F in the trough zone.

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STUDY OF LANTHANIDE(III) AND THORIUM(IV) CHLORIDE COMPLEXES WITH THIOUREAS

UREA and thiourea are suggested for the complexation of certain lanthanide and actinide salts and it is concluded that the ligands are bonded through 'O' and 'S' atom respectively¹⁻⁴. However a detailed spectroscopic study of lanthanides (III) and thorium (IV) chloride complexes of thiourea and its derivatives has not been made till now. So lanthanum (III), cerium (III) and thorium (IV) chloride complexes of thiourea, phenylthiourea, o-chlorophenylthiourea and

ethylenethiourea have been synthesized and their spectral, conductivity and magnetic studies have been carried out to establish the nature and type of bonding for the complexes.

Ethylenethiourea (entu) and *o*-chlorophenylthiourea (*o*-Cl-ptu) were prepared and purified according to the published methods^{5, 6}.

The complexes were prepared by treating the metal chloride and the ligand in ethanol and then extracting with petroleum ether (40–60°) or chloroform at 0° C. The products were washed with a mixture of ethanol and petroleum ether (40–60°) or chloroform (1:1) and dried in vacuum. The complexes were analysed for the metal, nitrogen and sulphur by standard procedures. The analytical data are presented in Table I.

meter (4000–400 cm⁻¹) and Beckman-IR 12 instrument (650–200 cm⁻¹) employing Nujol mull technique. NMR spectra were recorded on a Varian A-60 spectrophotometer in DMSO with TMS as external standard.

The complexes are colourless and amorphous and have stoichiometry ranging from 1:2 to 1:8. All complexes are 1:1 electrolytes⁷ except LaCl₃·3 entu which is found to be 1:2 electrolyte⁸ in methanol medium. The observed magnetic moments (B.M.) for Ce(III) complexes are in the range 2.49–2.82 and they are comparable to those recorded by Srivastava⁹ and Van Vleck¹⁰.

The infrared spectral data are presented in Table I. The absence of splitting in νNH bands (3200–3300 cm⁻¹) with slight increase in frequency

TABLE I
Elemental analysis, conductivity and IR frequencies

Compound	*Elemental analysis			Conductivity (ohm ⁻¹ M cm ² mole ⁻¹)	Infrared frequencies		
	M%	N%	S%		ν C-S	ν M-S	ν M-Cl
tu	..	..	..	..	630 mbr	..	..
CeCl ₃ · 6 tu	19.91 (19.58)	23.89 (23.75)	27.35 (27.30)	98.74	630 mbr	354 vs	110 w & br
ThCl ₄ · 3 tu	44.11 (44.10)	10.65 (10.60)	12.91 (12.65)	63.95	630 mbr	397 sh	244 w
ThCl ₄ · 8 tu**	23.61 (23.70)	22.80 (22.80)	26.16 (26.20)	73.11	622 ms	322 sh	242 w
ptu	..	..	..	..	637 s	..	..
LaCl ₃ · 3 ptu	19.39 (19.80)	11.98 (11.74)	13.71 (13.60)	105.4	637 s	303 vs	240 w
CeCl ₂ · 3 ptu	19.92 (20.10)	11.95 (11.90)	13.68 (13.50)	107.8	637 s	304 vs	206 w
entu	..	..	..	..	593 mbr	..	..
LaCl ₃ · 3 entu	24.95 (24.85)	15.08 (15.10)	17.26 (17.31)	143.7	590 ms	340 s	205 ms
ThCl ₄ · 8 entu	19.48 (19.45)	18.81 (18.75)	21.54 (21.40)	60.83	593 mbr	340 ms	212 w & br
<i>o</i> -Cl-ptu	..	..	..	..	624 mbr	..	..
LaCl ₃ · 3 <i>o</i> -Cl-ptu	17.40 (17.31)	10.97 (10.85)	12.04 (12.00)	116.5	628 mbr	353 ms	27 ms
ThCl ₄ · 4 <i>o</i> -Cl-ptu	20.71 (20.85)	10.00 (10.05)	11.45 (11.35)	63.50	624 mbr	320 sh	258 w

* The values in parentheses are calculated values.

** In KBr.

s = sharp; sh = shoulder; m = medium; br = broad; w = weak; v = very.

The molar conductivity was determined in methanol and the magnetic susceptibility values were taken at 25° C on a Guoy balance. Infrared spectra have been recorded on Perkin-Elmer-337 infrared spectro-

(10 cm⁻¹) and a small blue shift in ~1600 cm⁻¹ band (δ NH₂) reveals that nitrogen of NH₂ group is not participating in the coordination as suggested by Jensen and Nielsen¹¹. The strong band at 1470-1550 cm⁻¹ (ν_{asym} NCN

+ δ NH₂) shows blue shift on coordination indicating the increased double bond character of C=N bond. The band observed at 630 cm⁻¹ assignable to ν C-S clearly shows red shift in all complexes. These observations reveal the coordination of thioureas with the metal ion through sulphur. The above band assignments are in tune with those made by us earlier for similar complexes derived from *d*¹⁰ metal halides¹² and dioxouranium(VI) acetate.¹³ The bands recorded for ν M-S (200-400 cm⁻¹) analogous to the reports of other workers^{14, 15} also support sulphur coordination. The metal-halogen vibrations are also observed in far infrared region, as suggested by other investigators^{16, 17}.

The NMR study of La(III), Ce(III) complexes of phenyl thiourea indicates that the proton of imino group of this ligand (11.66 ppm, δ value) shows no shift for both complexes relative to free ligand. This observation favours sulphur bonding. The proton of NH₂ group in the above complexes as well as in the ligand are either insensitive in the NMR spectra or might have merged with aromatic peak (7.30 ppm, δ value).

The high coordination number (6 to 12) assigned to the above complexes speaks of the characteristic nature of lanthanide and actinide ions.

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AN EASY METHOD FOR THE ISOLATION OF FRUITING MYXOBACTERIA FROM VARIOUS SUBSTRATES

THE isolation procedures adopted for myxobacteria are very cumbersome on account of amoebal and fungal contaminants from soil. There are three basic procedures for the isolation of fruiting myxobacteria¹⁻⁴. The aerobacter circle method has been further developed by incorporating actidion and nystatin in the non-nutrient agar (NNA) base⁵⁻⁶. The fungal contaminants have been avoided to a considerable extent but the soil amoebae were still posing a problem. The present communication describes a method for the isolation of fruiting myxobacteria where these contaminants could be avoided appreciably.

Twenty-two soil samples, 68 samples of dung of herbivorous animals and 29 samples of tree barks were used for the present study. The original methods of Krzemieniewski³ and of Singh⁴ were compared with the present method. The present method comprised of a NNA base in which actidion and nystatin (each 50 μ g/ml) were incorporated in the medium. Twenty-four hour culture of red pigmented strain of *Serratia marcescens* was overlaid in the centre about 2.5 cm in diameter. This was inoculated with a pinch of the samples collected for the isolation of fruiting myxobacteria. The plates were incubated at 30 °C for 5-7 days. The myxobacterial fruiting bodies developed at the expense of *Serratia marcescens* cells.

It was observed that in *Serratia marcescens* plate the soil amoebae were very few and were not in active stage of multiplication; therefore, the picking up of