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HEALTH PROBLEMS IN FLUORIDE ENDEMIC AREAS OF GAYA DISTRICT

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KEYWORDS

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ABSTRACT

Fluoride (F) was estimated in the groundwater of six blocks (Bodh Gaya, Manpur, Wazirganj, Belaganj, Amas, and Bankebazar) of Gaya District, Bihar, for different physio-chemical properties e.g. pH, total dissolved solids (TDS), conductivity, turbidity, total hardness (TH), calcium, magnesium, iron and fluoride. Moreover 93 blood samples from different age groups including adult males, adult females and children from F affected areas were also analyzed for Hematological and Biochemical analysis. The F ranged from 0.24mg/L (Manpur) to 6.2mg/L (Bankebazar). Dhaneta (Bankebazar block) showed highest F level (6.2mg/L). The pre-monsoon F level was insignificantly different from post monsoon level ($t = 1.75$, NS). The F concentration in groundwater was found to be positively correlated with the pH suggesting the geogenic contamination. Reduced effects were seen on Hb, HCT, MCH, MCV, Ca, Glucose, while increased activity was seen in T3 and T4. Dental fluorosis was predominant in F endemic villages (Dhaneta, Bhupnagar, Bhaktauri and Masuribaar). About 69.5 % adults and 87.65% children were suffering from dental fluorosis. Skeletal fluorosis was found in Dhaneta, Bhaktauri and Bhupnagar (42.64% adults, 80% children). Residents of F endemic areas complained of Neurological Disorders (*i.e.* Headache and Insomnia). In Dhaneta village of Bankebazar block, 55% adult males, 63% adult females and 35% of children suffered with neurological problems, while in Bhaktauri village of Bankebazar block, 71% adult males and 75% adult females suffered with headache and insomnia. In Bhupnagar village of Amas block, 88% of adult males, 76.3 % of adult females and 50% of children were found to have neurological disorders. The study shows that Fluoride in drinking water is causing major health problems in the residents of F endemic areas of Gaya District.

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INTRODUCTION

Various natural and anthropogenic activities result in the contamination of groundwater with fluoride (F), arsenic, nitrate, sulfate, pesticides, etc. leading to myriad of health problems. The problem of excessive fluoride (F) in ground water in India was first reported in 1937 in the state of Andhra Pradesh (Short *et al.*, 1937). High concentration of F (1.5mg/L) in groundwater have been reported in the states of Haryana, Delhi, Rajasthan, Karnataka, Uttar Pradesh, Maharashtra, Gujarat, Madhya Pradesh, Tamil Nadu, Kerala, Jammu and Kashmir, Punjab, Orissa, Himachal Pradesh and Bihar (Susheela, 2000). F exposure disrupts the synthesis of collagen and leads to breakdown of collagen in bone (Susheela and Jha, 1981). Its excessive intake may result in slow, progressive crippling condition known as fluorosis. Fluoride depresses thyroid activity also (Gorlitzer Von, 1963). This paper reports about the groundwater quality of certain regions of Gaya district, with special emphasis on fluoride contamination and its impact on human health.

Topology and geology of study area

Gaya district is located at 84.4° E to 85.5 °E L and 24.5°N to 25.1°N L and has total area of 487607.83 km². The greater part of Gaya district is occupied by the Gangetic alluvium, but older rocks rise above its level, chiefly in the south and east. These rocks are mostly composed of foliated gneiss, a subdivision of the Archean system which contains the oldest rocks of the earth's crust (O'malley, 2007). The Gidhour hills lay across the southern boundary of Gaya composed of Dharwars, including micaceous and ferruginous schist so highly metamorphosed by intrusive coarse pegmatitic granites that they yield mica. The north eastern part of district are mainly quartzite and slate and very barren because of lack of forests. The south east corner of district is situated in the middle of rich mica belt.

MATERIALS AND METHODS

A total of 31 villages of Bodh Gaya, Manpur, Wazirganj, Belaganj, Amas and Bankebazar blocks in Gaya district of Bihar were included in this study. Twenty samples of drinking water were collected from each block, except Bankebazaar, from where 23 samples were collected. Likewise 123 samples were collected and analyzed for fluoride and other physico-chemical parameters. The samples were collected during the pre-and post-monsoon in pre-cleaned high density polypropylene sample (1L) bottles and stored at 4°C before analysis. Fluoride (F) level was measured by using Fluoride Ion selective electrode Orion 9690 BNWP with PCD 650 cyber scan portable meter. Commercially available Ion strength adjusting buffer *i.e.* ISA I was added to the samples before the estimation of fluoride. Other physico-chemical parameters were estimated according to APHA-AWWA-WPCF(1995). Hardness and Calcium were estimated with EDTA Titrimetric methods. pH, conductivity, TDS and turbidity were measured by Portable PCD 650 multi tester. Iron was estimated with the Phenanthroline method. Moreover 93 blood samples from different age groups including adult males, adult females and children from F affected areas were also analyzed. Various hematological and bio-

Table 1: Fluoride concentration in water samples

Blocks	Villages	No of Samples	Mean \pm S.E. (pre-monsoon)	Mean \pm S.E. (post-monsoon)	Range of Fluoride (mg/L)	No. of samples exceeding the desirable limit of 1 mg/L
Bodh Gaya	Shillonja, Chotki Basadhi, Bakraur, Tekuna, Kharanti, Bagdaha	20	0.49 \pm 0.04	0.64 \pm 0.02	0.55-1.0	0
Manpur	Alipur, Gangti, Manpur pehani, Lakhanpur, Rasalpur, Rampur, Budhgere, Mayapur	20	0.46 \pm 0.04	0.44 \pm 0.05	0.24-1.1	1
Wazirganj	Karhauna, Dhuriyawa, Singhaura, Motibigha, Bharaiti, AarshGali	20	0.82 \pm 0.09	0.69 \pm 0.1	0.32-1.7	3
Amas	Bhoop Nagar, Rampur, Masooribaar	20	1.8 \pm 0.23	1.7 \pm 0.19	0.89-3.2	13
Belaganj	Beladih, Paranpur, Siyaram colony, Korma, Yadavpur	20	0.42 \pm 0.01	0.35 \pm 0.01	0.3-0.46	0
Bankebazar	Dhaneta, Bhaktauri, Kamalpur	23	2.0 \pm 0.28	2.01 \pm 0.3	0.71-6.2	15

chemical analysis were done to see the possible effect of F on their health. The blood was collected in Heparinized vials. The hematological analysis was done with the help of Automatic Hematolyzer (Sysmex KX-21). Further plasma was separated for biochemical analysis. The reagents kits of ERBA make were used for blood analysis. The levels of ALP, SGPT, creatinine, glucose, LDH, calcium, uric acid were measured by using Blood Chemistry analyzer (Biotech BT-260 plus). The level of T3, T4, and TSH was measured by ELISA reader (ERBA Lisa scan EM). The health survey was conducted with a pre-designed questionnaire.

RESULTS AND DISCUSSION

Fluoride concentration in the groundwater of different blocks is presented in Table 1. None of the samples of Bodh Gaya and Belaganj blocks had F above the desirable limit of 1.0

mg/L (BIS 2003). In Manpur Block, Mayapur village had F level of 1.1mg/L. In Wazirganj, Bharaiti village (1.7mg/L) and Karhauna village (1.6mg/L) recorded higher fluoride concentration (above the WHO permissible limit). In Amas F level ranged between 0.89-3.2mg/L. Bhoop Nagar was the main F affected village. Masuribaar village had F level ranged from 0.42-1.86mg/L. In Bankebazar block F level ranged from 0.71-6.2mg/L. Dhaneta and Bhaktauri were F endemic areas. Dhaneta showed maximum F level of 6.2mg/L.

A positive correlation was found between pH and fluoride ($r=0.257$, Fig. 1a) which indicates that alkaline nature of the water promotes leaching of fluoride from rocks. The alkaline water can mobilize fluoride from rocks with precipitation of calcium carbonate because the solubility of Fluorite (CaF_2) increases with an increase in NaHCO_3 rather than with other salts (Handa, 1975; Saxena and Ahmed, 2001, Sunitha, 2012).

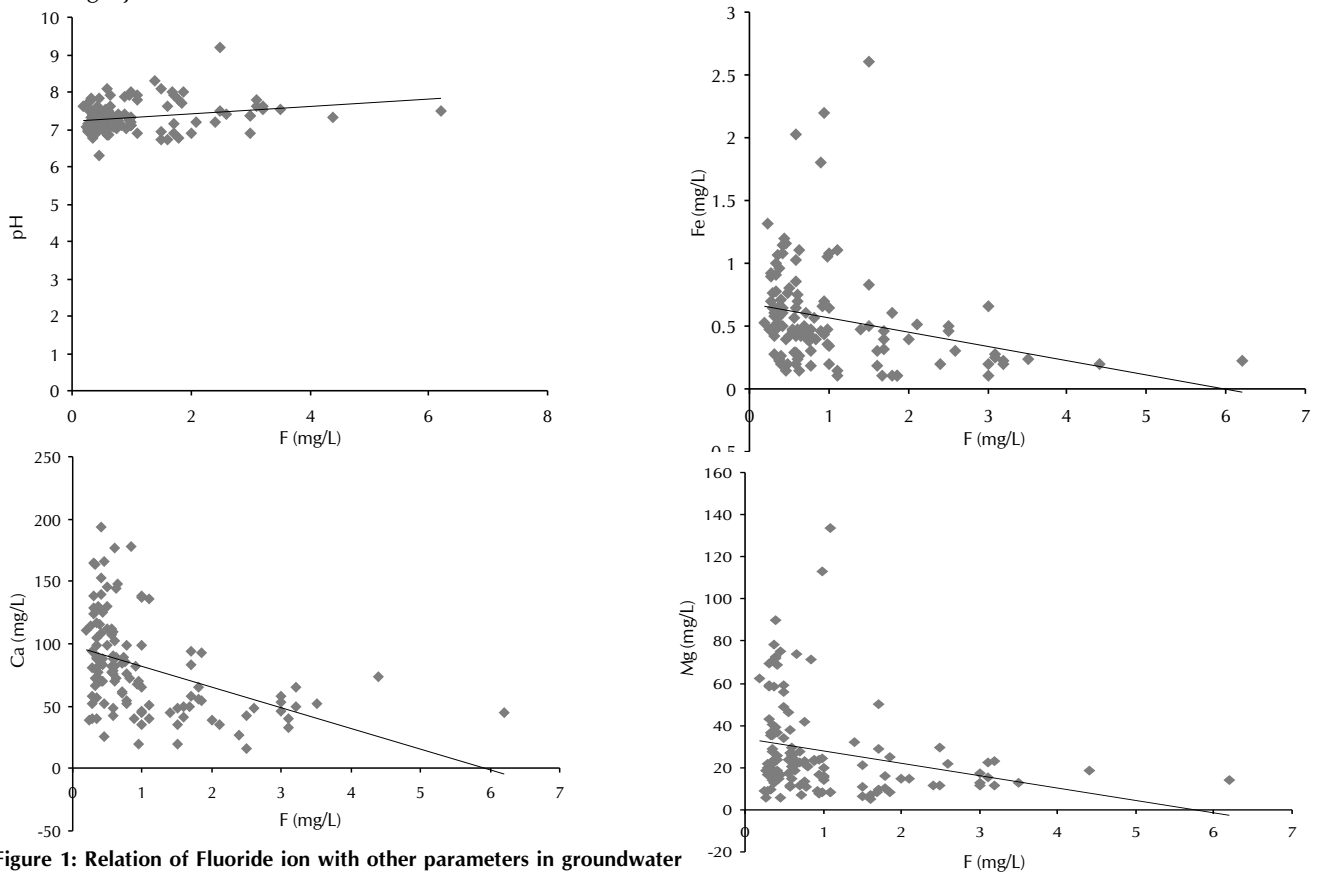


Figure 1: Relation of Fluoride ion with other parameters in groundwater

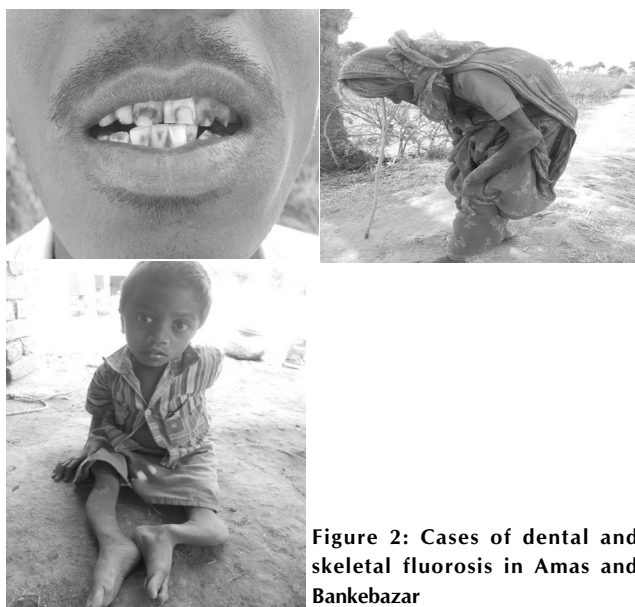


Figure 2: Cases of dental and skeletal fluorosis in Amas and Bankebazar

A negative correlation was found between the Ca ($r = -0.43$), Fe ($r = -0.26$) as well as Mg ($r = -0.25$) (Fig. 1 b, c and d) and F levels in the water samples. This indicates low solubility of F with these ions (Das et al., 2003). There was insignificant difference in the F level between the pre monsoon and post monsoon ($t = 1.75$, NS).

Health complaints of the surveyed blocks are presented in Table 2. Residents of F endemic areas also complained of Neurological Disorders (i.e. Headache and Insomnia). It has been found that F can reduce levels of melatonin, the sleep hormone, in the body, causing chronic insomnia (Heliman, 1998). Spittle (1994) has also recorded cases of severe headache in adult subjects exposed to F in their drinking water. Sharma et al. (2009) found an increase in the severity of neurological ailments with the increase in F concentration in drinking water. Residents of Amas (Bhoop Nagar, Masooribaar) and Bankebazar block (Dhaneta, Bhaktauri) were found to

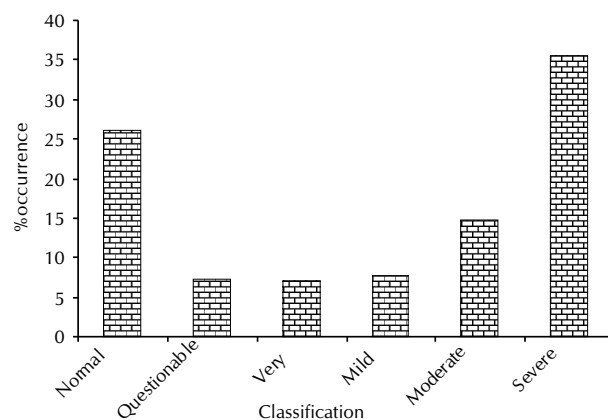


Figure 3: Dental Fluorosis in F endemic villages (Bhupnagar, Masuribaar, Bhaktauri and Dhaneta) as represented by Dean's Index (N = 446)

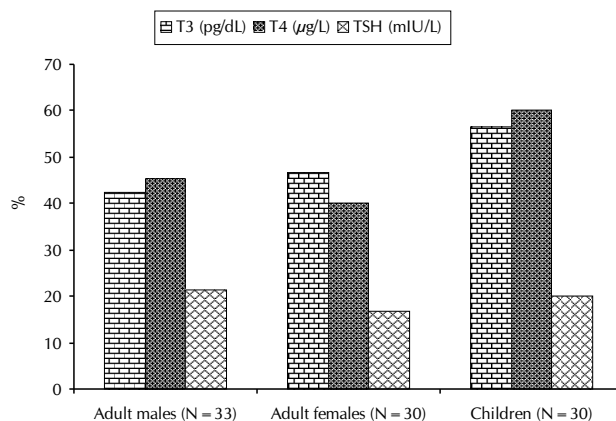


Figure 4: Incidence of hyperfunction of thyroid gland in the F endemic areas

suffer with skeletal fluorosis (adults 42.64%, children 80%), dental fluorosis (children 87.65%, adults 69.5%) (Fig. 2). Further the classification with Dean's Index showed that the

Table 2: Health complaints in fluoride affected villages of Gaya district

Blocks	Fluoride level(mg/L)		Health complaints							
	Mean	Range	Dental caries	Dental fluorosis	Skeletal fluorosis	Joint pain	GI Problems	Headache	Insomnia	
Bodh gaya (n = 321)	0.64 ± 0.02	0.55-1.0	Adult males(n=166)	21(12.6%)	0	0	1	37(23%)	6(0.03%)	4(2%)
			Adult Females(n=169)	24(14.2%)	0	0	40(23%)	30(18%)	15(8%)	21(12%)
			Children(n=69)	19(27.5%)	0	0	0	2	0	0
Manpur (n = 638)	0.44 ± 0.05	0.24-1.1	Adult males(n=265)	11(4%)	0	0	7(2%)	63(23%)	45(16%)	10(3%)
			Adult Females(n=265)	5(1%)	0	0	71(26%)	74(0.27%)	55(20%)	24(9%)
			Children(n=109)	12(1%)	0	0	0	24(22%)	0	0
Wazirganj (n = 567)	0.69 ± 0.1	0.32-1.7	Adult males(n=253)	49(19%)	0	0	15(5.9%)	65(25%)	20(7%)	14(5%)
			Adult Females(n=251)	40(15%)	0	0	72(28%)	61(24%)	29(11%)	14(5%)
			Children(n=117)	22(18%)	0	0	0	31(26%)	7(5%)	0
Belaganj (n = 418)	0.35 ± 0.01	0.19-0.46	Adult males(n=174)	6(4%)	0	0	18(10%)	32(18%)	10(5%)	0
			Adult Females(n=165)	8(4%)	0	0	44(26%)	28(16%)	21(12%)	8(4%)
			Children(n=79)	8(10%)	0	0	0	38(48%)	7(8%)	0
Amas (n = 349)	1.74 ± 0.19	0.89-3.2	Adult males(n=147)	52(35%)	72(48%)	18(12%)	76(51%)	64(43%)	43(29%)	12(8%)
			Adult Females(n=138)	33(23%)	47(34%)	7(5%)	79(57%)	55(39%)	36(26%)	7(5%)
			Children(n=64)	35(54%)	35(54%)	14(21%)	27(42%)	24(37%)	12(18%)	0
Bankebazar (n = 301)	2.0 ± 0.3	0.62-6.2	Adult males(n=125)	79(63%)	75(60%)	53(42%)	65(52%)	46(36%)	29(23%)	26(20%)
			Adult Females(n=126)	60(47%)	60(47%)	35(27%)	72(52%)	55(43%)	36(28%)	29(23%)
			Children(50)	36(72%)	36(72%)	34(68%)	34(68%)	34(68%)	6(12%)	0

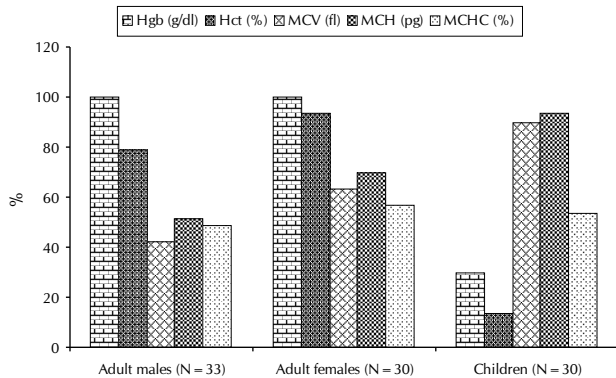


Figure 5: Reduction of certain blood parameters below normal in the F endemic areas

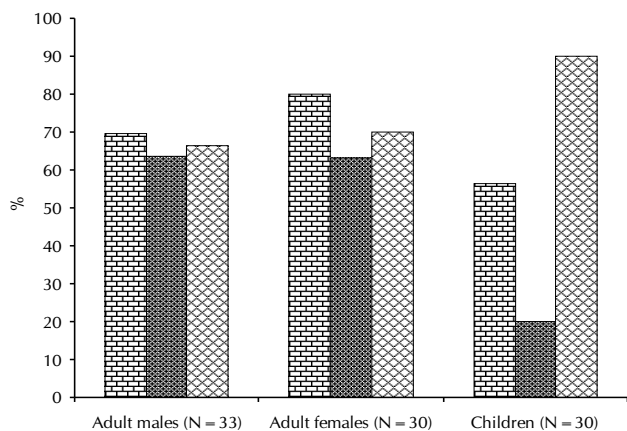


Figure 6: Reduced hematocrit showing anaemia in the F endemic areas

residents were suffering from severe dental Fluorosis (Fig. 3). Biochemical analysis showed that higher T3 and T4 level in residents of F endemic areas (Fig. 4). Hypocalcemia and lowered creatine in blood were also evident in all age groups (Fig. 5). Similar findings were also reported by Barot (1998). The blood analysis of residents of F endemic villages showed lowered Hgb level in all the adult residents (Fig. 6). According to Susheela and Jain (1985) F causes changes in the blood cell profile and anaemia. However, the involvement of poor nutrition cannot be ruled out.

CONCLUSIONS

This study identified that Karhauna and Bharaiti villages in Wazirganj block, Bhoopnagar, and Masooribar villages in Amas block, Bhaktauri and Dhaneta from Bankebazar block were affected due to Fluoride contamination of groundwater. High fluoride level as well as other physico-chemical parameters in these blocks might be due to geological formation. The study would help to map the endemic areas of Gaya district with respect to fluoride contamination. Mapping

of high fluoride area may be useful to plan and make available safe drinking water in the fluoride affected areas.

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REFERENCES

- American Public Health Association (APHA). 1995.** Standard methods for the examination of water and wastewater, 19th edn. American Public Health Association, Washington DC.
- Barot, V. V. 1998.** Occurrence of Endemic Fluorosis in Human Population of North Gujarat, India: Human Health Risk. *Bull. Environ. Contam. Toxicol.* **61**: 303-310.
- Das, B., Talukdar, J., Sarma, S., Gohain, B., Dutta, R. K., Dutta, H. B. and Das, S. C. 2003.** Fluoride and other inorganic constituents in groundwater of Guwahati, Assam, India. *Curr Sci.* **85(5)**: 657-661.
- Handa, B. K. 1975.** Geochemistry and genesis of fluoride containing groundwater in India. *Ground Water.* **13**: 275-281.
- Heliman, B. 1998.** Fluoridation of water: Questions about health risks and benefits remain after more than 40 years. *Chem Engineering News.* pp. 26-42.
- Gorlitzer Von, M. V. 1963.** Influence of fluoride and iodine on the metabolism, particularly on thyroid gland. *Muenchener Medicische Wochenschrift.* **105**: 182-186.
- O'malley, L. S. S. 2007.** Bengal District Gazetteer: Gaya. Concept Publishing Company.
- Saxena, V. K. and Ahmed, S. 2001.** Dissolution of fluoride in groundwaters: a water-rock-interaction study. *Environ Geol.* **40**: 1084-1087.
- Sharma, J. D., Sohu, D. and Jain, P. 2009.** Prevalence of neurological manifestations in a human population exposed to fluoride in drinking water. *Fluoride.* **42(2)**: 127-132.
- Short, H. E., McRobert, T. W., Bernard, A. S., Mannadinayer, A. S. 1937.** Endemic fluorosis in the Madras Presidency. *Ind. J. Med. Res.* **25**: 553-561.
- Spittle, B. 1994.** Psychopharmacology of fluoride: a review. *Int Clin Psychopharmacol.* **9**: 79-82.
- Sunitha, V., Muralidhara Reddy, B. and Ramakrishna Reddy, M. 2012.** Variation of fluoride and correlation with alkalinity in groundwater of shallow and deep aquifers- A case study in and around Anantapur district, Andhra Pradesh. *Int. J Applied Sci Engineering Res.* **1(4)**: 569-575.
- Susheela, A. K. 2000.** A treatise on fluorosis, Fluorosis Research and Rural Development Foundation, 1st Ed; New Delhi. p. 1-119.
- Susheela, A. K. and Jha, M. 1981.** Effect of Fluoride on cortical and cancellous bone composition, IRCS Medical sciences: library compendium. **9(11)**:1021-1022.
- Susheela, A. K. and Jain, S. K. 1985.** Fluoride toxicity: Erythrocyte membrane abnormalities and echinocyte formation. In: Fluoride Research, Studies on environmental sciences. Ed. Tsunoda H and Yu MH. Elsevier, Amsterdam. **27**: 231-239.

