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湿地の保全再生と賢明な利活用

Restoration and Wise Use of Wetlands

報　告　書

Proceedings

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collection location and the habitats of plants. The following are issues. To use specimen information, it is important to develop a database with enormous amounts of information on specimens stored in a museum of the whole country. In addition, information on latitude, longitude, and altitude has to be unified. Detailed habitat descriptions are also important for site information, since analysis on habitat and distribution need various sources of information.

Table 3 Characteristic of rural communities including habitat of *Isoetes japonica* and *Rotala pusilla*

Ratio of paddy fields of cultivation abandonment	Ratio of land readjustment of paddy fields (over 30a)					
	0-20(%)	20-40	40-60	60-80	80-100	Total
0-1(%)	14	5	0	9	7	35
1-5	50	7	8	8	6	79
5-10	22	3	1	2	0	28
10-20	15	0	0	1	0	16
20-100	15	0	0	0	0	15
Total	116	15	9	20	13	173

We described how to find a hot spot of hydrophytes by using the habitat data of botanical specimens in combination with GIS. Then, by overlapping a land use and data of rural communities by Census of Agriculture and Forestry, we could understand the characteristics of their habitat.

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P−009J

カンボジア・トンレサップ湖の氾濫原植生：季節的な水位変動とヒトの利用の狭間で

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はじめに

カンボジアの中央部に位置するトンレサップ湖は、インドシナ半島最大の淡水湖である。この湖にはメコン河の水が遡上し、もっとも増水する10～11月には、減水期（４～５月）に比べて水位が８mも上昇し、冠水面積は４倍に拡大する（Okawara and Tsukawaki, 2002; Mildenhall and Tsukawaki, 2002）。低平な湖岸域に広がる氾濫原は、アンコール王朝時代から地域の経済・文化を支える豊富な水産・林産資源や多様な生物相を育む源泉とみなされてきた（Mekong River Commission, 1997; CNMC/NEDECO, 1998a, b）。しかし、基礎調査さえ不十分なままユニークな生態系の多くが荒廃し、今では胸高直径（DBH）が30cmを越える*Barringtonia acutangula*（Lecythidaceae：サガリバナ科）の樹冠がやぶ状の低木林上に突出して散在している景観が認められる（McDonald et al., 1997）。この荒廃は薪利用を目的とした現地住民の施業により引き起こされており、この伐採によって住民の生活基盤の消失が懸念される事態が生じている。

しかしながら、終戦後間もないカンボジアではタイやベトナムなどの隣国に比べて、植物相や植生に関する研究はほとんどなく、特にトンレサップ湖とその周辺の氾濫原に関する情報は極めて限られている（e.g., McDonald et al., 1997; Sokhun, 1997; CNMC/NEDECO, 1998b）。本報告では、植物生態学・資源植物学の

視点から実施した氾濫原植生の現状、特に（1）季節的な様相の変化と（2）浸水林の破壊・自己修復の把握に関する調査結果を報告する。

調査地と調査方法

調査地としたのは、トンレサップ湖の北西部を占めるシェムリアプ州の湖水・氾濫原域で、アンコール遺跡群から20kmほど南方に位置する（13° 16' N, 103° 49' E）（Fig. 1）。徒歩や舟で調査地を踏査し、（1）40箇所に方形区（10 m×10 m）を設置して（Fig. 1a）、Braun-Blanquet（1964）の基準に従った植物社会学的手法によって植生の組成と分布を調査した。また、（2）29箇所に方形区（10 m×10 m）を設置して（Fig. 1b）、DBHが5cm以上の樹木を対象とした毎木調査法によって残存林・低木林の構造および優占種*B. acutangula*の更新特性をそれぞれ調べた。本研究では、氾濫原植生に関連する材木搬出の履歴や野焼き、耕作、開墾といった聞き取り調査を現地住民に対して実施した。

結　果

減水期の陸化した氾濫原では、湖心側から内陸に向かって、水生草本植物群落→*B. acutangula*高木林→やぶ状の疎林・低木林→耕作放棄地・耕作地が順に卓越していた。また*B. acutangula*は、（1）伐採や開墾によって退行した群落内でもBAの優占率が85%以上となって圧倒的に優占し（Fig. 2）、（2）全個体のうち71.5%が切り株からの萌芽を呈し（Fig. 3）、（3）早い成長段階で花実を生産し、大型の実は増水期に水流によって運ばれ、（4）多くの実生が氾濫原一帯の明るいミクロサイトに定着すること（Fig. 4）によって盛んに更新していた。一方、満水期にはこうした植生は水没し、代わって水草が繁茂して、5型の生活形に応じて成帯的に分布していた。今回の調査によって、（1）氾濫原における植生構造や植物種多様性に、冠水期間や水深と同調した異質の2相の季節的動態が強く関与している実態が判明し、また（2）*B. acutangula*や水草の生活史特性を活かして、生活基盤としての氾濫原を順応的に修復・管理するための方向性が見出された。

謝　辞

カンボジアのアンコール遺跡整備機構と興業省資源局の皆様には、現地調査において多大なるご助力を賜った。ここに厚く御礼申し上げる。本研究は、UNESCO MAB-IHPと科学研究費補助金（15405004）、金沢大学21世紀COEプログラム、横浜国立大学21世紀COEプログラム「生物・生態環境マネジメント」、科学研究費補助金（18650236）の補助を受けて行われた。

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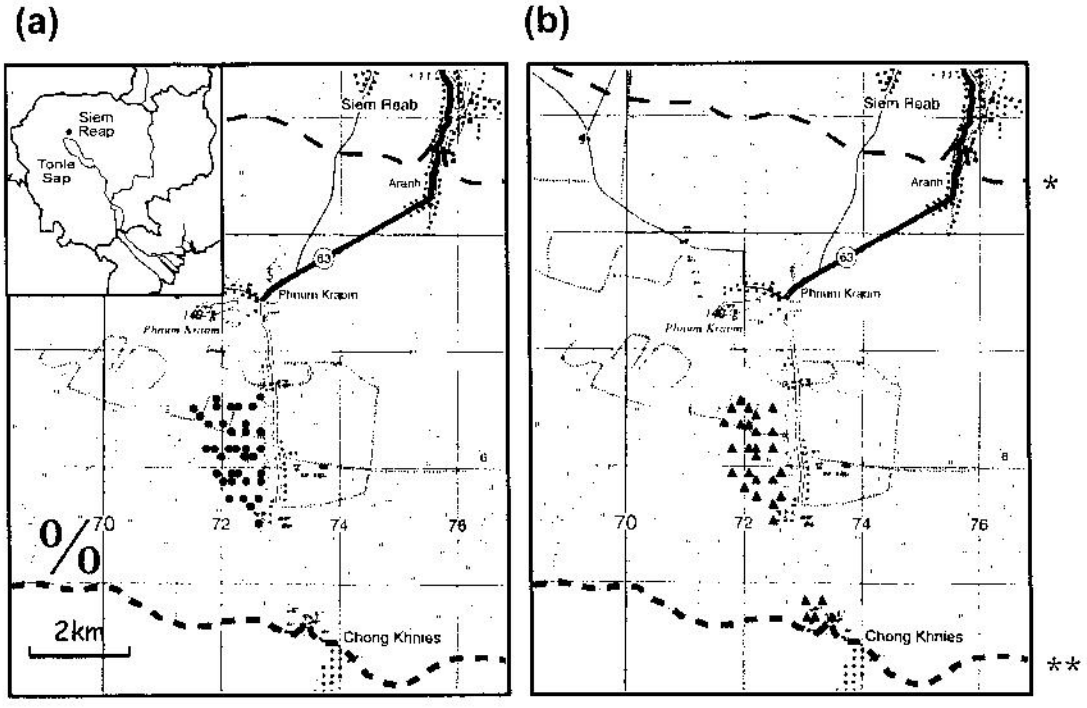

Fig. 1. 調査地と調査区位置図. (a) 植生調査区 (●, n=40). (b) 毎木調査区 (▲, n=29). *: 最高水期の湖岸線. **: 最低水期の湖岸線.

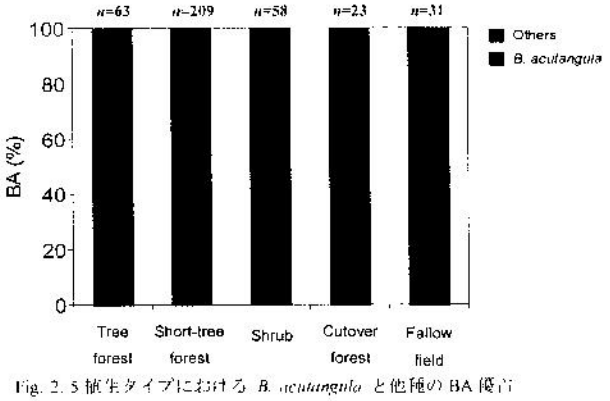

Fig. 2. 5植生タイプにおける *B. acutangula* と他種のBA優占率の比較. BA: ベーサルエリア.

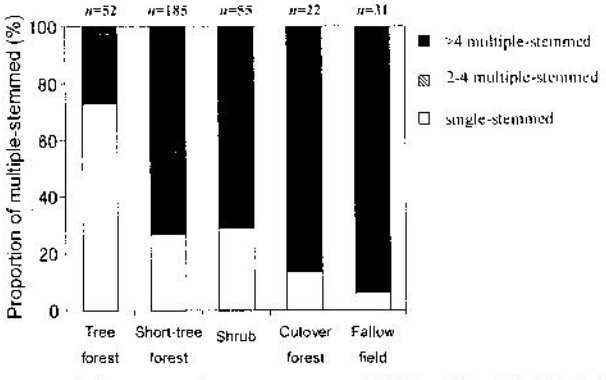

Fig. 3. 5植生タイプにおける*B. acutangula* の萌芽個体の割合の比較. 植生タイプ間で有意差が認められた. ($P<0.001$, Fisher's exact test).

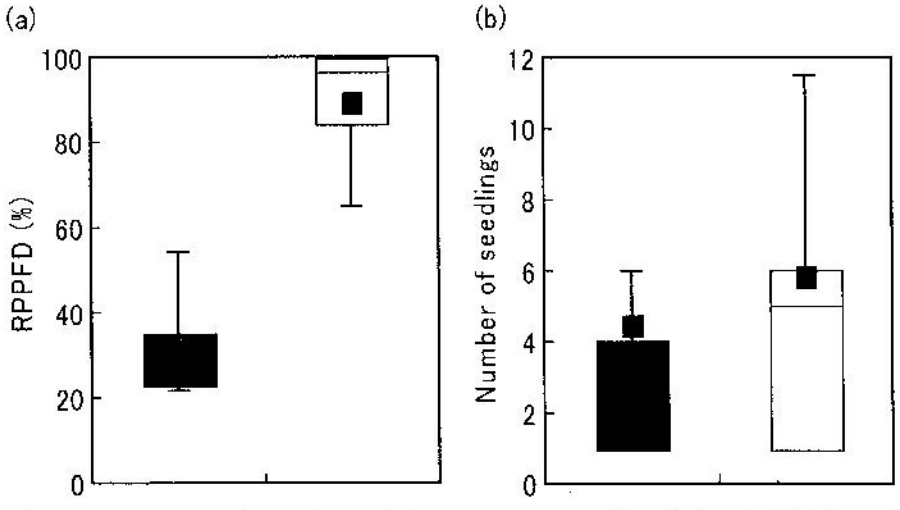

Fig. 4. 植被下 (n = 38) とギャップ (n = 30) におけるB. acutangula の実生数の比較。 (a) RPPFD、 (b) 実生数。図中箱の上辺、底辺、中央線はそれぞれ分布の75%、25%、50%を表し、縦棒線の上線と下線は90%と10%を表している。箱中央のシンボルは全データの中央値を意味する。植被下とギャップとで、RPPFDと実生数ともに有意な差が認められた (Wilcoxon's sign rank test, (a) $P < 0.05$、 (b) $P = 0.019$)

Floodplain vegetation of the Lake Tonle Sap, Cambodia: between seasonal water-level change and human impact

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Introduction

The Lake Tonle Sap, the largest inland water body in Southeast Asia, contains unique wildlife and ecosystems adapting to its large seasonal fluctuations of water level. In the highest-water season (October - November), waterlogged area expands four times as large as that in the lowest-water season (April - May) and the maximum depth reaches to more than eight meters (Okawara and Tsukawaki, 2002; Mildenhall and Tsukawaki, 2002). The Lake Tonle Sap has played important roles in economy and culture of Cambodia as a major source of fish, wood, fertile agricultural land and other natural resources (Mekong River Commission, 1997; CNMC/NEDECO, 1998a, b). But, most of the floodplain forests are already severely disturbed. We can see isolated tree trunks of ***Barringtonia acutangula*** (Lecythidaceae, some in excess of 30 cm DBH) that occasionally emerge from the shrub canopy invariably support a reduced and disturbed crown (McDonald et al., 1997). This phenomenon is due to the activities of fuelwood collectors that habitually prune the larger branches for firewood. These last remnants of a forest vegetation suggest that *B. acutangula* probably was a dominant component of the original forest cover (McDonald et al., 1997).

However, Cambodia is still very poorly known, the information on the flora and vegetation in the Lake Tonle Sap and its surrounding lowlands is quite limited (e.g., McDonald et al., 1997; Sokhun, 1997; CNMC/NEDECO, 1998b). In this paper, ecological evaluation of the floodplain forest was attempted paying attention to the ecological characteristic of *B. acutangula*. First, we study vegetation structure of floodplain by using phytosociological method. Secondly, we analyze the relationship between vegetation succession and human behavior. Thirdly, we investigate the regeneration characteristics of *B. acutangula*, a dominant species of the remnant stunted swamp forest fringing along the coastal part of the floodplain.

Site and Methods

The study area is situated in the southern part of Siem Reap City (13° 16' N, 103° 49' E) (Fig. 1). After general observations of the plants in the study area on foot and on the boat, we set 40 quadrats (10 m × 10 m) (Fig. 1a). We surveyed maximum height, coverage of vegetation and species name, and measured coverage for each species by Braun-Blanquet scale (Braun-Blanquet, 1964). On the other hand, 29 quadrats (10 m × 10 m) were set on both short-tree and shrubland vegetation and forest vegetation (Fig. 1b), measured height and DBH of tree (stems > 5 cm DBH), flowering and the number of stem each individual were also recorded. We also interviewed with local people on how they have been concerned with floodplain vegetation; i.e., history of logging, burning, reclamation and cultivation.

Results

In the high-water season, there were many herbaceous water-plants on the water. But, in the low-water season, floodplain is no longer covered with water, and the floodplain forest appears. In the present study, in the low-water season, five vegetation community types classified, these were distributed in order from the lake side to inland as below: "Herbaceous water-plants community", "*B. acutangula* Tree forest", "Short-tree forest - Shrub" and "Fallow field - Cropland".

Our investigation found that the human behavior caused retrogressive succession on the floodplain against vigorous regeneration ability of ***B. acutangula*** and some shrub species mentioned above. On the other hand, even in the community which retrogressed by cutting or cultivation, ***B. acutangula*** regenerated actively such as: (1) this species extra dominated so that the proportion of basal area occupies 85 % or more in any vegetation type (Fig. 2), (2) 71.5 % of individual sprouted new shoot from stumps (Fig. 3), (3) the flowers were produced in the early growth stage, and dispersed large and floating seeds by water movement, (4) a large number of seedlings were established in the sunny micro site of expanse of the floodplain (Fig. 4).

Consequently, by this investigation, (1) it was found that inundation period and seasonal water-level change had a great impact on the vegetation structure and the plant diversity on the floodplain. Moreover, (2) it was suggested the direction to adaptively restore and manage the floodplain as a infrastructure of human life by taking advantage of life history strategy of ***B. acutangula*** and other water plants.

Acknowledgement

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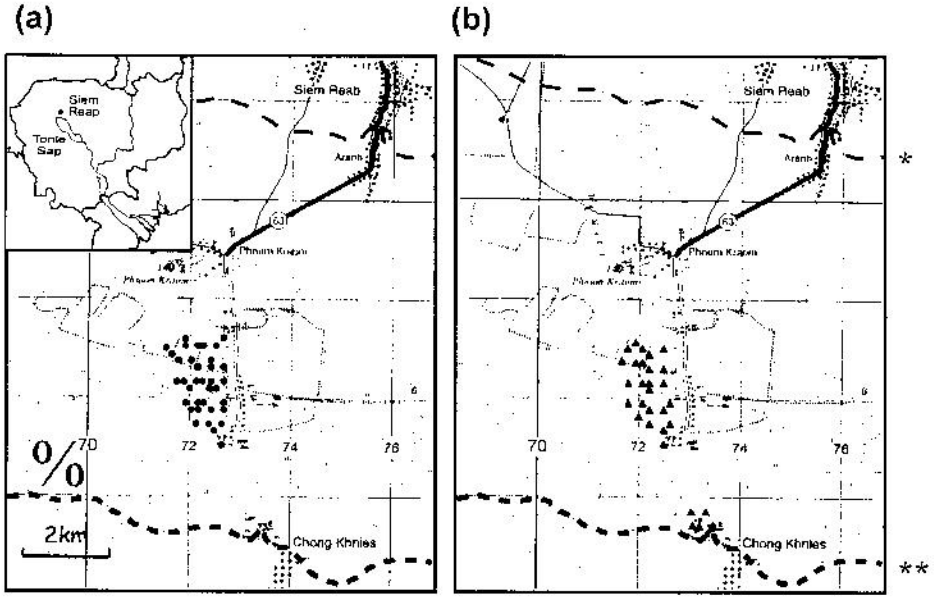

Fig. 1. Location of the research area and sampling plots. (a) 40 vegetational research quadrats (●). (b) 29 quadrats of survey on the structure of forest (▲). *: Coastline in the highest water season. **: Coastline in the lowest water season.

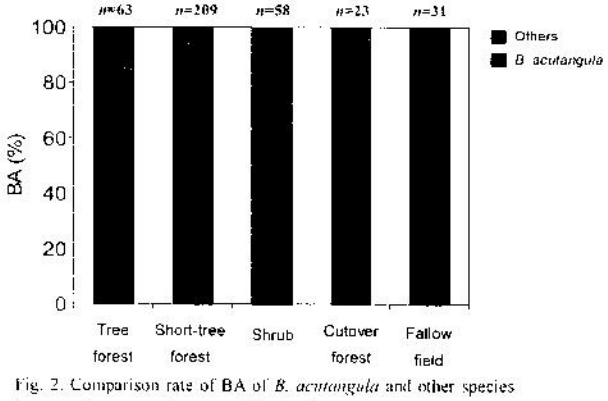

Fig. 2. Comparison rate of BA of *B. acutangula* and other species between five vegetation types. BA: Basal area.

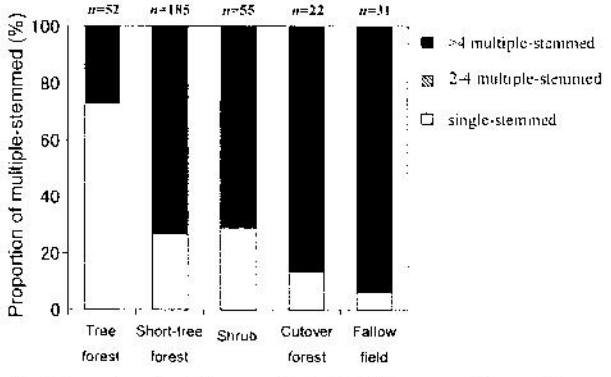

Fig. 3. Proportion of multiple-stemmed individual of *B. acutangula* between five vegetation types. Values were significantly different between vegetation types at $P<0.001$ (Fisher's

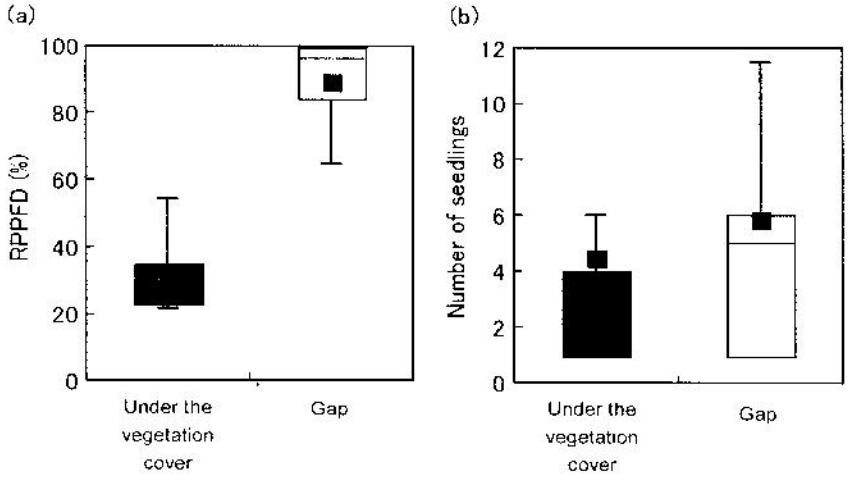

Fig. 4. Comparison a number of B. acutangula seedlings between Under the vegetation cover (n = 38) and Gap (n = 30). (a) RPPFD and (b) a number of seedlings. The top, bottom, and middle line of the box corresponds to the 75th percentile (top quartile), 25th percentile (bottom quartile), and 50th percentile (median), respectively. The whiskers extend from the 10th percentile (bottom decile) and the top 90th percentile (top decile). The symbol within the box represents the mean for the data range. Results were significantly different compared between under the vegetation cover and gap (Wilcoxon's sign rank test, (a) $P < 0.05$, (b) $P = 0.019$).