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## 体格・体力・体質の国際比較学的研究

沢田 芳 男

昭和49年3月1日 受付

第1次熊本大学アフリカ現地人体質学術調査隊は、昭和46年の9月上旬から12月上旬にわたって、西アフリカのガーナと東アフリカのケニアにおいて調査を行なった。

本調査は、昭和46年度の文部省科学研究費海外学術調査補助金による調査研究として、熊本大学体質医学研究所教授沢田芳男が研究担当者になり、研究協力者には同研究所の助教授土井永記、今井義量、同研究所の助手長尾愛彦、有江醇子、小郷克敏、伊達鉄二の協力を得て、合計7名で行なわれた。

われわれがアフリカの原住民を調査の対象に選んだ理由の一つは、アフリカにはさまざまな生活様式や形質をもつ民族が住んでいるが、この大陸の歴史的、文明的、民族的特徴に目をつけ、諸部族特有の生活環境下に形成された形態的あるいは機能的特質の調査を実施して、現時点におけるアフリカ現地人の体格・体力・体質に関する多様な資料の収集につとめ、日本人や欧米人には求めることのできない資料を確保し、日本国民の体力向上に役立てようと考えたためである。

もう一つは、人間は本来“自然”の中で十分に身体を動かすことにより、身体はもちろん精神の健全さを維持することができるものであり、むしろ身体の諸器官は、これを用いないときは、その機能の衰退を招く場合が多い。近年における家庭電化、自動車その他交通機関の発達、エレベーター、エスカレーターなど発達する機械文明は確かに生活に利便と快適さをもたらしているものの、反面では生活や仕事の上での省力化という形で身体活動の機会を奪いつつあるものといえよう。このように近代文明のめざましい発展は、逆に人間の生物としての本来の必要な運動をさまたげ、日

常生活においてもだんだん身体活動の少なくなる傾向がうかがわれる。このことは人間の健全な心身の向上発達を阻害することになりつつあって、いわば体質医学面から“自然”を見つめ、人間のあがままの原始の姿を探ることによって、現代日本人の体力向上に役立てようと考え、その原点を、機械文明に最も遠い国の一つであろうと思えるアフリカに求めたわけである。

われわれは、昭和46年夏に成案に達した国際標準体力テスト、ならびに文部省のスポーツテストに準拠し、さらに現地への検査機器の運搬や現地事情などを考慮して、つぎのような調査内容を設定した。

- 1 形態と身体組成面での特徴をつかむための生体計測
  - 1) 身長、体重、座高、肩峰幅、腸骨稜幅、胸郭横径、胸郭矢状径、胸囲、右上腕囲、右前腕囲、右手囲、右大腿最大囲、右大腿最大囲、皮下脂肪厚（右上腕背部、肩甲下部、右上腕腹部、右前腕腹部、臍部、腸骨稜上部、右大腿前部、膝窩下部）
  - 2) 写真計測：無作為に抽出した被験者について
- 2 機能面での特徴をつかむためのテスト
  - 1) 体力診断テスト：背筋力、握力、肺活量、立位体前屈柔軟度、仰臥上体起こし、垂直とび、シャトル・レース(Shuttle run)
  - 2) 運動能力テスト：50m走、立ち幅とび、ハンドボール投げ、懸垂腕屈伸、屈腕懸垂持続時間
- 3 食生活調査
- 4 Phenylthiocarbamide (PTC) による味盲調査

5 ミミアカ（耳垢）の性状調査

6 発毛や乳房の形態など第二次的性徴の調査

このうち、体格・身体組成、生理的測定、運動能力、食生活調査、PTCによる味盲調査、ミミアカの乾・湿性状調査などの成績を中心に、得た結果の概要を紹介しよう。

最初の調査国は西アフリカのガーナ。そのギニア湾に面した漁港都市・ウィネバとケープコーストにおいて5歳から32歳までの1,791名（うち男子1,041名、女子750名）を、昭和46年9月から10月下旬にわたって検査した。

もう一つの調査国は東アフリカのケニア。その海拔1,800mの高原にあるナクル市一帯の小、中、高校生1,671名（うち男子918名、女子753名）を、10月下旬から12月初旬にわたって検査した。

1 体格・身体組成について

ガーナ、ケニア人と比較した日本人の身長、座高、脚長（身長から座高を引いた値を脚長とみなす）、体重、胸囲の資料は昭和45年度の文部省学校保健統計調査報告書、上腕囲、下腿囲の資料は

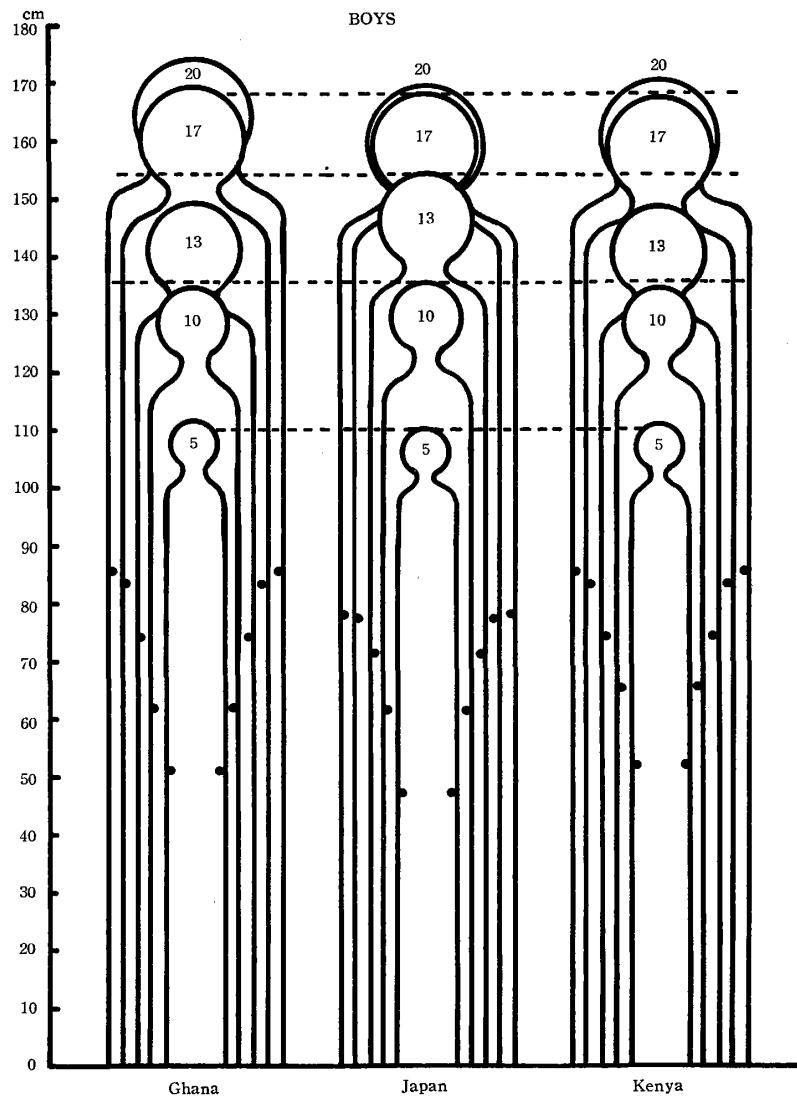


Fig. 1 Comparison of growth from stature and leg length for boys in Ghana, Kenya and Japan.

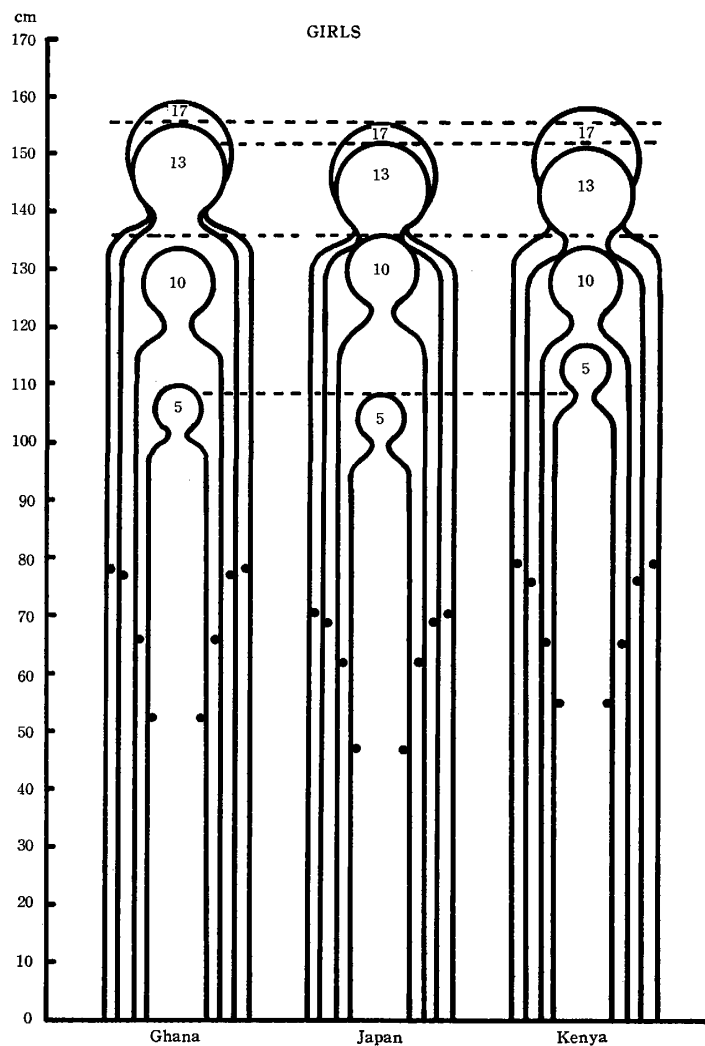


Fig. 2 Comparison of growth from stature and leg length for girls in Ghana, Kenya and Japan.

日本人の体力標準値（東京都立大学身体適性学研究室編），皮脂厚の資料は伊達鉄二の報告を用いた。

こけしをモデルとして，アフリカと日本の子供たちの身長の年齢的推移を比較したのが図1（男子），図2（女子）である。

顔の数字は年齢を，体の両側にある点は脚長を示す。

図1に示すように，男子5歳ではガーナ，ケニアとも日本より高い値を示しているが，10歳では逆転し日本のほうが高い。これが13歳まで続いているが，その後，日本の発育は停滞気味なのに対

し，ガーナ，ケニアともかなりの伸びを示し，17歳では日本の値に接近，あるいは追い越している。17歳から20歳にかけてガーナ，ケニアとも，かなりの伸びが認められるのに対し，日本の伸びはきわめて少ない。

図2の女子の場合では，日本の値は5歳ではガーナ，ケニアより低いが，10歳では日本のほうが高い値を示している。しかし，13歳ではケニアは日本の値に近づき，ガーナは日本の値を凌駕し，17歳では日本の値が最も低い。

このように，男女とも長育のスパート時期は日本のほうがアフリカの子供より早いようであるが，



思春期後の発育の伸びは小さい。

なお、沢田芳男はデンマークと日本の子供を比較した場合にもアフリカの場合と同じような傾向のあることを報告している。

男子身長の間年発育量のカーブは、日本は高いほうの峰が12歳～13歳、低いほうの峰が6歳～7歳にある二峰性であるのに対し、ガーナは6歳～7歳、10歳～11歳、13歳～14歳に峰をもつ三峰性、ケニアは7歳～8歳、11歳～12歳、14歳～15歳に峰をもつ三峰性で、しかも日本の年間発育量の最大を示す時期はガーナ、ケニアより若いところにある。女子の間年発育量のカーブは、アフリカ、日本ともに二峰性であるが、年間発育量の最大を示す時期は日本のほうがガーナ、ケニアより1年齢ほど若いところにある。

座高は、ケニアの5歳女子を除き、男女各年齢とも、いずれも日本のほうがかなり高い。ガーナとケニアの間には明確な違いはない。

脚長は、丁度座高と反対の傾向、すなわち、日本は男女各年齢とも低い値である。なかでも思春期後の彼我の差はかなり著明である。

体重は、身長と同じように成人ではアフリカ現地人の値が日本人の値より大きくなるが、男子では10歳～17歳、女子では9歳～11歳で一時日本人のほうが重い。ケニアの女子においては16歳以後における体重の伸びが大きいことが特徴的である。

胸囲は、男子においては10歳から19歳にかけて日本のほうが、ガーナ、ケニアの値よりすぐれ、値は日本、ケニア、ガーナの順である。女子においては10歳から15歳にかけては日本のほうが、ガーナ、ケニアの値よりすぐれている。しかし、16歳以後ではケニアの値は日本と同じか、ややすぐれた値を示している。

上腕囲は、男子においては各年齢とも日本の値がかなり大きく、ガーナとケニアの値はかなり接近している。女子においては思春期後ガーナ、ケニアの値は日本の値をかなり凌駕している。

下腿囲は、男子においては各年齢とも日本の値がかなり大きく、とくに思春期後のひらきが大きい。ガーナとケニアの値はかなり接近しているが、一般にガーナはケニアの値より僅かに大きい傾向

にある。女子においては9歳以後日本の値はガーナ、ケニアよりやや大きい値を示している。11歳から15歳にかけてはガーナの値はケニアの値よりやや大きい、その他の年齢では接近した値である。

以上、身長、座高、脚長ならびに周囲径などの成績から、全体的に日本の子供たちよりアフリカの子供たちのほうが男女とも下肢は長くて細く、座高は低く、いわゆる欧米人並みのスマートな体つきである。

皮下脂肪の厚さ（皮脂厚）についてみるに、肩甲下部の皮脂厚は男子では6歳、女子では6歳と9歳を除く各年齢において日本はガーナ、ケニアの値を上回っている。なかでも10歳、11歳の差は、それより若い年齢における差を大きく上回っている。

男子の上腕背部皮脂厚は肩甲下部の場合に似た傾向を示しているが、女子の場合は年齢によって多少の違いはあるが、大体においてガーナ、日本、ケニアの順に値は小さくなっている。

臍部の皮脂厚は図3に示すように、男女、各年齢とも日本の値が最も高く、彼我の差はかなり著明である。なお、皮脂厚は各国とも女子のほうが男子より厚い。このように一般的にアフリカの子供たちの皮脂厚が日本の子供たちのそれより薄い傾向にあることは、アフリカの環境に順化した姿であるとも考えられるが、それよりも日本の子供は遊び場が少なく、運動不足のせいによるものではないだろうか。

つぎに、肥満やるいさうの程度を示唆するローレル指数〔体重(kg)/身長<sup>3</sup>(cm)×10<sup>7</sup>〕についてみるに、男女ともほとんどの年齢において日本の値のほうが高く、日本の子供はアフリカの子供に比べるとやや肥満の傾向にあることがうかがえる。

## 2 生理的測定について

ここには背筋力、握力、肺活量、立位体前屈柔軟度に関する成績の概要を紹介するにとどめる。ガーナ、ケニアと比較した日本の資料は日本人の

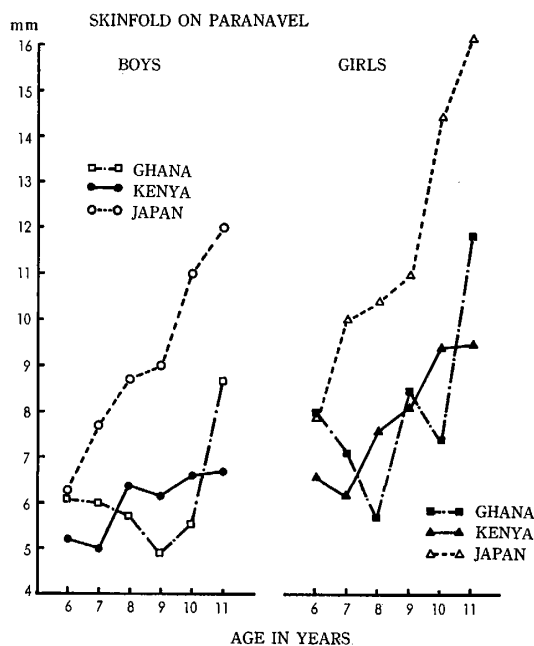


Fig. 3 Mean skinfolds on paranael at ages from 6 to 11 years for boys and girls in Ghana, Kenya and Japan.

体力標準値（東京都立大学身体適性学研究室編）によった。

背筋力について、男子ではガーナ、ケニアともに日本人標準値を下回り、18歳では日本人標準値に対してガーナは76%、ケニアは78%と低い。女子でもガーナ、ケニアともに日本人標準値を下回り、17歳では日本人標準値に対してガーナは82%、ケニアは85%である。

背筋力の年間発達量を算出すると、日本男子では12歳から13歳にピークがあり、ガーナ、ケニアはこれより2年遅れ14歳から15歳にピークがある。日本女子では9歳から10歳にピークがあり、ガーナでは11歳から12歳に、ケニアでは10歳から11歳にピークがある。すなわち、背筋力発達のスパートの時期は、日本の子供はアフリカの子供より1ないし2年早い。

握力では、ケニアの男子5歳から10歳までは日本人標準値より高い値を示しているが、その他の年齢では日本の値よりやや低い。ガーナの値は日本の値よりも低く、ケニアの値よりもやや低い。17歳では日本人標準値に対してガーナは85%、ケニアは92%である。女子では、ガーナは5歳から

10歳までは日本よりやや低いが、その後は日本の値とほぼ近似の値で、15歳、17歳では日本より高い値を示している。ケニアは11歳と13歳を除く各年齢において日本人標準値より高い値を示し、14歳以後の彼我の差は大きくなる傾向が認められる。17歳では日本人標準値に対してガーナは106%、ケニアは112%と高くなっている。日本人女子の握力は成熟とともに横ばい状態にあって、あまり伸びない傾向が認められる。

比握力も握力と同じような傾向が認められる。

握力の年間発達量についてみるに、日本男子では13歳から14歳にピークがあるが、ガーナ、ケニアの男子はこれより1年遅れて14歳から15歳にピークがある。日本およびガーナ的女子では10歳から11歳にピークがあり、ケニアでは11歳から12歳にピークがみられる。すなわち、握力発達のスパートの時期は、日本の子供のほうがアフリカの子供より1年ばかり早いようである。

これらの筋力では日本の値はガーナ、ケニアの値を上回っているところもあるが、女子の握力では成熟とともに日本人の値は横ばい状態にあって、ほとんど伸びない。成熟した段階での男女比をみ

るに、背筋力ではガーナ、ケニア、日本ともに60%前後であるが、握力ではガーナは74%、ケニアは76%、日本は65%で、日本の男女差のほうが大きい。

肺活量では、男女ともにガーナはケニアより上回るが、日本より下回る値である。

立位体前屈柔軟度では、男子においてはガーナの7歳を除き、各年齢とも日本のほうがまさっている。ガーナとケニアを比較するに、各年齢ともガーナのほうがかなり高い値を示している。女子ではガーナの8歳、9歳、ケニアの18歳の値を除き、日本のほうが高い値を示し、一般的に日本の子供のほうが柔軟性にとんでいる傾向が認められる。ケニアの子供は若年齢では日本よりかなり低い値であるが、思春期ごろから値は急上昇を示し、18歳では日本の値を僅かではあるが凌駕し、柔軟性の発達の著明なことがうかがえる。

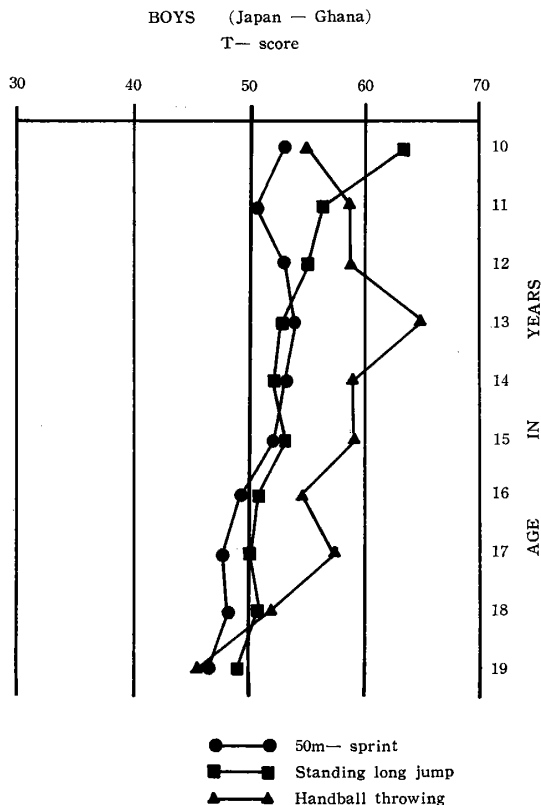


Fig. 4 Result of conversion of Japanese data into T-score based on Ghanaian average and standard deviation.

### 3 運動能力について

運動能力の基本とみなされる走、跳、投について比較してみよう。

これら運動能力のガーナの平均値と標準偏差をもとにして日本の値を T-score に換算した成績は図4、図5に示すとおりである。

図4は50m走、立ち幅びび、ハンドボール投げの男子の T-score であるが、思春期ごろは日本の値がすぐれ、その後はガーナのほうがまさる傾向のあることを示している。図5によるガーナと日本の女子の比較では、ハンドボール投げでは日本の女子がかなりすぐれ、50m走でも日本のほうが僅かにすぐれている傾向にあるが、彼我の差はかなり接近している。立ち幅びびではガーナのほうが一般にすぐれている傾向にあることがうかがえる。

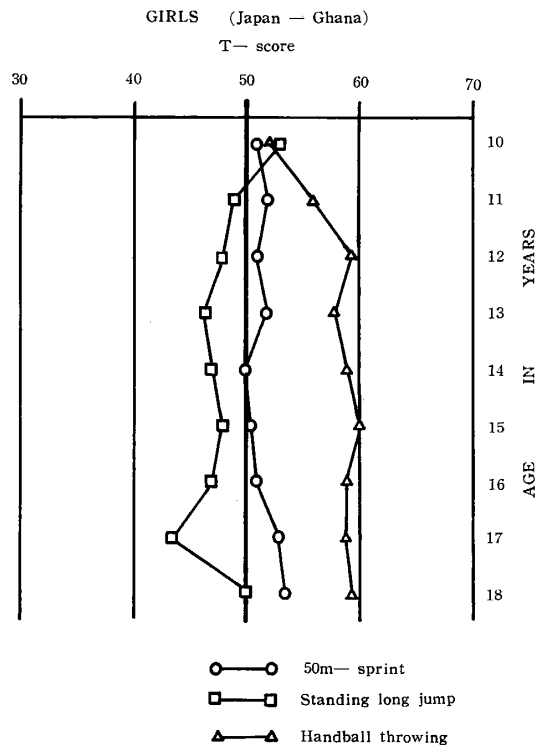


Fig. 5 Result of conversion of Japanese data into T-score based on Ghanaian average and standard deviation.

走, 跳, 投能力のケニアの平均値と標準偏差をもとにして日本の値を T-score に換算した成績は図 6, 図 7 に示すとおりである。

すなわち, 男子の比較 (図 6) においては, ガーナと日本の比較の場合と同じように, 思春期を過ぎるとケニアのほうが高まってくる傾向にあることが認められる。ケニアと日本の女子の比較では, ケニアのほうが高まる傾向にあることが認められる。

アフリカの子供達は, これらの運動能力テストを生れて初めて受けたわけで, このことは日本の子供に比しかなりのハンディキャップのあるわけだが, 日本の子供の能力より高まっている点があることが認められた。なかでも運動の基本となる走力においてアフリカの子供がすぐれている傾向にあることは, 日本の子供達のおかれている文化的と称する近代社会ならびに日常的な生活環境な

どと考え合わせて大変興味深いものがあるように思う。さらに, アフリカの子供達がボールを手で扱い, あるいは投げる機会が少ないにもかかわらず, とくにケニアの子供は投能力にまさっている。このことも大いに考えさせられることだと言えよう。

#### 4 食生活調査について

ガーナは地理的には北半球にある熱帯圏で, 北緯 4 度 45 分から北緯 11 度 11 分の間, 東経 1 度 12 分から西経 3 度 15 分の間ひろがる面積 238, 537km<sup>2</sup> (日本の約 3 分の 2), 人口約 854 万人で, 南北に長い長方形の国である。南はギニア湾に面し, 西アフリカ諸国のほぼ中央に位置し, 奴隷商人が往来した奴隷海岸のなかで黄金海岸と呼ばれたイギリス植民地であった。昭和 32 年 3 月 6 日,

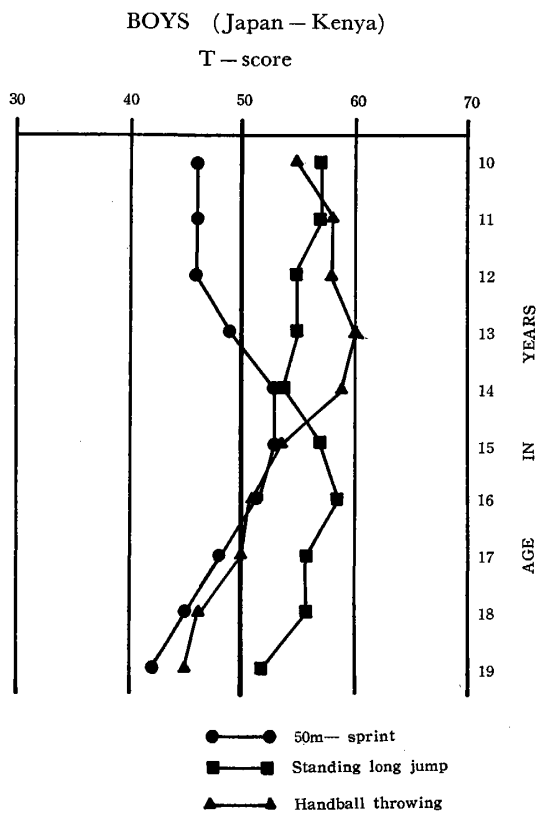


Fig. 6 Result of conversion of Japanese data into T-score based on Kenyan average and standard deviation.

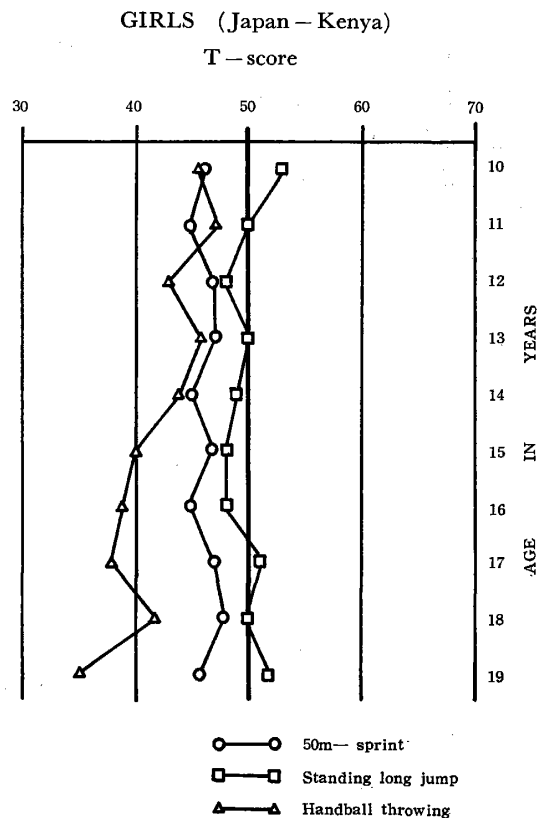


Fig. 7 Result of conversion of Japanese data into T-score based on Kenyan average and standard deviation.

第2次世界大戦後サハラ以南のアフリカで最初に独立をかちとった国である。

ガーナの気候は熱帯性気候であるが、地形は海岸に続く平地地帯と標高1,000mにたりないアクワビム・トーゴ山脈があるだけで、主としてサハラ砂ばくから吹きよせるハマターン(hamattan)と南の海上から吹き上げる湿度の高い南西貿易風とによって影響をうけている。海岸地帯のアクラでは、1月から3月にかけてはハマターン期で気温が最も高く、5月から6月におとずれる大雨期のあと、7月、8月、9月は気温の低い乾期となり、10月ごろ小雨期となる年間の周期をもっている。内陸部クマシではアクラよりやや気温は低く雨量は多くなっていてアクラと同様に2回の雨期と2回の乾期がある。さらに奥地タマレの北部森林地帯では年間の平均気温が30Cを越えることはないがアクラよりやや気温が高く、5月から9月までの1回の雨期と1回の乾期にとどまるようである。われわれが9月から10月にかけて滞在したウィネバヤケープコーストなどの海岸地帯においては朝夕は25C前後の気温で、日中やや気温の上昇をみるが絶えず海風が吹き続け、室内では暑さを感じる程ではなく、熊本のと夏に比較すると、かなりしのぎやすかった。

ガーナの海岸地帯にあるウィネバヤケープコースト市における現地人の食生活について紹介してみよう。

主食の代表はトウモロコシであるが、最近の都市化にともないパン食、米食に移行する傾向にあ

り、酪農製品と共にこれら輸入食糧は大きく増加している。

小麦は食パンとして家内工業的に至るところで焼かれ、どんな田舎のマーケットでも必ず手に入れることができる。米はやわく煮て辛いたれなどで食べ、高級な主食とされている。トウモロコシは彼等にとってふるさとの味で、発酵トウモロコシ粉(Corn dough)からつくられたチマキはケンケイとかバンクーとか呼ばれる。

穀類の外に糖質源としてヤム、ココヤム、カサバ、プランティンなどがある。カサバは土地条件を選ばないため、あらゆるところにつくられているが、彼等は低い階層の食品であるという考えをもつ傾向がある。ジャガイモは輸入品であるため高価であり、サツマイモは品種が悪いことと栽培技術が悪いことでまれに見かける程度である。

表1に芋類とデンプン類の食品成分を示す。

つぎに副食についてみるに、食品の種類はかなり少ない。彼等は果物を除いては野菜類および魚介類に至るまで生食の習慣はない。日本食がみそとしょう油で調味されているように、この奴隷海岸一帯では多量の油でタマネギをいため、トマトと薫製の魚とトウガラシと塩で調味する習慣がある。このことは多量の油とタンパク質とインドカレーのような辛さが熱帯の環境条件に適した調理法であることを示唆しているように思える。肉類、豆類、野菜類を単独で、または数種混合して煮たのち上記の調味法で調理している。

油脂源としてのあびらシンの実はトウガラシと

TABLE 1 Composition of potatoes and starch foods

(per 100 g)

Food stuff	Calorie Cal	Protein g	Lipid g	Ca mg	Fe mg	Vitamin A I.U.	Vitamin B <sub>1</sub> mg	Vitamin B <sub>2</sub> mg	Nicotinic acid mg	Vitamin C mg
Yam	109	2.5	0.4	21.2	0.7	—	0.10	0.04	0.4	11
Cocoyam (Taro)	138	2.1	0.4	14.1	1.1	—	0.10	0.04	0.7	11
Cassava	148	1.1	0.4	31.8	0.7	—	0.07	0.04	0.7	35
Sweet potato	124	1.4	0.4	35.3	1.1	100	0.10	0.04	0.7	24.7
Irish potato	75	2.0	0	10	0.7	0	0.10	0.03	1.5	15
Plantain	124	1.1	0.4	7.5	0.7	318	0.07	0.04	0.7	17.6

共に煮て、うすで果肉をつきつぶし、水で果肉液を抽出し、かすを沓過し、この液でスープやシチュウをつくる。これは産婦にとって好ましい食物だといわれている。あぶらヤシからとったパームオイルも果肉液同様に橙赤色をしており、カロチノイドが非常に多く含まれている。油脂類は副食物の外に間食として、塩ピーナッツとタイガーナッツが多く出回っていて安価なため多く消費されている。ワニナシも油脂を多く含む果物であり、海岸地帯に豊富なココヤシの実と共に庶民の油脂源である。

一般の動物性タンパク源としては魚を最も利用している。日本では煮ほしやかつおぶしを使うように薫製の魚の身をほぐしダシとして多量に用いる。漁業の規模は小さく、一本の木をくりぬいたカヌーに小さい発動機をつけた沿岸漁法による地びき網で、ほとんど毎日水揚げがある。大抵はあじ、さば等の小魚で占められ、直ちに海岸で取り引きされる。これらの魚は一部生のまま売られるが、大半はから揚げか薫製に加工される。したがって、泥で円形につくった魚薫製用のかまどは漁村地帯では至る所に見られる風物である。

魚の外にはクワメ・ヌクルマのプロジェクトのうち、ただ一つ成功したという養鶏業によって魚より高価であるが鶏卵が出回っている。部落には放し飼いの鶏やヤギを飼う習慣があり、これらもある時期の動物性タンパク源となっている。組織的な畜産業は普及していないため畜肉は少なく、その上大都市以外は冷凍、冷蔵設備がないため手に入りにくい。

野菜類は品目が少ないが筆頭はトマトであろう。野生に近い品種で形は小さく、よく熟したものをを用いる。タマネギ、ナスビ、オクラ、ココヤムの葉、トウガラシがマーケットで取り引きされる。

果物類では、まずオレンジがあげられる。ネーブルとグレープフルーツの中間のような味で甘味も多く、供給は豊富であり安価である。グレープフルーツ、バナナも多く消費されている。時期によってはマンゴーやパパイヤも市場に出回り、熱帯地方の特殊性としてこれら果物類は価格の上で安価であり、ビタミン類の供給源となっている。

表2に1人1日当たりの摂取栄養量を示す。この表には1日の総量と朝食を抜いた場合の1日量を算出表示した。この計算は Ghana Food Table in Ounces と Ghana Recipe Book によった。比較のため昭和43年度国民栄養調査成績（厚生省）の日本人1人1日当たりの摂取栄養量をあげると、ガーナ人が朝食を抜いた2度の食事と果物による間食のほうが、カロリーを除いて日本人1人1日当たりの摂取栄養量より高くなっている。なかでもタンパク質と脂質、ビタミンAの価がとくに高い。間食で果物を摂食するかしないかでビタミンCの摂取量が大きくかわってくるが、コーラ1本（約52円）と150gのオレンジ6コが同じ価格で入手できることは、ビタミン補給の上できわめて好都合なことである。

ケニアは昭和38年12月12日に英連邦内に自治国として独立、翌年の12月12日に待望の共和国となった。東インド洋に面し東経42度から、西はビクトリア湖に至る東経34度まで、北緯4度40分から南緯4度40分までにわたり、その中央部を赤道によって南北両半球にわかれている。面積は582,646km<sup>2</sup>で、ほぼ日本の1.6倍にあたり、人口は10,890,000人、日本の総人口の1割に満たない人口希薄な国である。

アフリカ大陸の屋根といわれるキリマンジャロに次ぐ第二の高峰、ケニア山がほぼ中央にそびえ、西には1,000mから1,800mの高原地帯が続き、東はインド洋に向って海岸地帯がひらけている。気候風土は適温適雨の高原地帯と高温多雨の海岸地帯、高温少雨の荒野、半砂ばくである東北地帯と大きく三つに分けることができる。国土全体を通じて年間気温は2月、3月が高く、8月が最も低く、雨期は3月から5月にかけての大雨期と11月から12月にかけての小雨期がある。

ケニアの首都ナイロビから北西へ鉄道沿いに約156kmのところにあるナクル市に、昭和46年10月から12月にかけて滞在し、その間に得た現地人の食生活について紹介しよう。

放牧民で農耕をせず、物資の交流を拒否する一部の部族を除いてケニアではトウモロコシが主食である。その食べ方としてウジ(Uji)と呼ばれ

TABLE 2 Comparison of nutritional intake by per head for a day in Ghana and Japan

Menu	Meal time	Food stuff	Amount g	Calorie Cal	Protein g	Lipid g	Ca mg	Fe mg	Vitamin A I.U.	Vitamin B <sub>1</sub> mg	Vitamin B <sub>2</sub> mg	Nicotinic acid mg	Vitamin C mg	
<b>Menu A</b>	Breakfast	Bread	140	361	11	1.0	20	1.0	0	0.14	0.06	1.0	0	
		Margarine	8	64	0	6.8	0	0	240	0	0	0	0	
	Lunch	Groundnut Soup	236	574	51	40.4	355	3.5	102	0.42	0.32	18.0	18	
		Konkonte	400	358	1.5	0	62	4.3	0	0.44	0.04	1.2	0	
	Supper	Fresh Fish Stew	580	800	100	45	209	10.7	2,090	0.65	1.04	14.0	39	
		Kenkey	300	414	10.5	2.1	10.5	2.1	0	0.30	0.12	2.1	0	
	Snack	Orange	150	80	2.7	0.6	53	0.53	264	0.10	0.06	0.53	49	
		Banana	120	102	1.7	0.5	13	0.42	254	0.05	0.06	0.84	13	
	Total daily amount			1,934	2,753	178.4	96.4	722.5	22.55	2,950	2.10	1.70	37.67	119
	Total amount without breakfast			1,786	2,328	167.4	88.6	702.5	21.55	2,710	1.96	1.64	36.67	119
<b>Menu B</b>	Breakfast	Rice Water	350	175	3.4	0.4	5.5	0.6	0	0.04	0.02	0.9	0	
		Milk	100	148	7.0	7.8	212	0.4	318	0.04	0.40	0	0	
		Bread	70	180	5.5	0.5	10	0.5	0	0.07	0.03	0.5	0	
	Lunch	Jolloff Rice	367	822	38	45.4	58	3.7	1,696	0.30	0.35	3.4	29	
	Supper	Bean Stew	348	814	69.5	45.1	712	7.4	18,873	0.70	0.41	6.0	52	
		Banku	300	414	10.5	2.1	10.5	2.1	0	0.30	0.12	2.1	0	
	Snack	Pear (Avocado)	100	176	1.8	16.2	14.0	0.7	212	0.07	0.25	0.2	31.8	
	Total daily amount			1,635	2,729	135.7	117.5	1,022.0	15.4	21,099	1.52	1.58	13.10	112.8
	Total amount without breakfast			1,115	2,226	119.8	109.3	794.5	13.9	20,781	1.37	1.13	11.70	112.8
	Nutritional average intake by per head for a day on a nation-wide basis*				2,253	77.1	44.6	530.5	—	1,420.9	1.10	0.96	—	96.1

\* The source of data: Ministry of Welfare, Japan: Present state of national nutrition, 1968.

るポリッジとウガリ (Ugali) と呼ばれる固いポリッジを荒びきのトウモロコシ粉からつくる。生トウモロコシは水煮とするかイリオ (Irio) というカボチャの葉などと煮たものをつくる。粒トウモロコシを素焼きのつぼで長時間煮ることもある。トウモロコシを主食とする階層は低所得階層であることから動物性タンパク源に乏しく、豆類によるタンパク摂取という栄養的知識にも欠けていることが多い。なお、ヤム、カサバ、ジャガイモなども主食であるが、最近では、米はトウモロコシより味がいいし、米よりもパンや小麦製品は手軽に食べられることから主食に対する嗜好は変遷してゆく傾向にある。一方、バナナとか牛乳という従来の主食を変えようとしなない部族もある。都市化にしたがって、より精白度の高い米が好まれ、白い小麦粉、白いトウモロコシが好まれてきている。授乳についても10%以上の母親が子への母乳をやめて牛乳による授乳を行なっている。これらのことは、のぞましくない都市化の一面ではないだろうか。

ナクル市はリフトバレー州の中心地として高冷地農産物の集散地となっており、二大部族：キクニ族とルオ族の会合地点として多くの部族が集った人口約5万人の地方都市である。この地域はリフトバレーで生産される穀類、野菜、果物などの農産物や大牧場からの酪農品、畜肉などの畜産品が安価で入手できる。食習慣はパンとコーヒーか紅茶に牛乳を入れたもの、ローストビーフかシチュウという方向に傾いているが、主流はトウモロコシ中心の食事で量もかなり多い。

表3は調査に基づいて算出した農耕民であるキクニ族、ルオ族の食事内容で1人1食当たりの摂取栄養量を示している。

献立Dは、この都市の現地人学童の給食である。毎日、給食車によって校庭に運ばれ、子供達はピクニックのように校庭で食事をする。この献立は、いつも変らない。量は、やや多く、小さい子供は残している。

表4は表3の献立を組み合わせ、成人1日の摂取栄養量を算出したものである。これは、この地域での現地人の標準を示すものと考えてよいので

はなからうか。食事を楽しむというところまではゆかないが、栄養上の必要最小量は確保できる内容ではある。しかし、ややもするとタンパク質や脂質、ビタミン類の不足を招きやすい。

M. C. Latham の東アフリカでの地域性、習慣性を考慮に入れた食品の組み合わせをみると、つぎのとおりである。

ケニアコースト (Kenya Coast) は東アフリカの良港モンバサ市を中心とした熱帯性気候の海岸地帯であり、米作がおこなわれており、漁業も盛んである。米と魚を主にして豆、緑葉野菜と果物というとり合わせであって、日本人の食形態によく似ている。

ブガンダ (Buganda Village) はウガンダでビクトリア湖の北方、内陸の高地で雨量も多い。プランティンという料理用バナナにサツマイモ、牛肉、豆、野菜のとり合わせである。

ナイロビ (Nairobi) はケニアの首都で、ホワイトハイランドの中心地でもある。ここではヨーロッパナイズされた生活が営まれている。食品は豊富で、各種選ぶことが可能であって、都市化されたパン中心の内容である。

ビクトリア湖畔 (Lake Victoria Shore) では雨量の多い高地農作物に、湖で捕獲される魚類がもちいられる。トウモロコシに豆類と魚、果物のとり合わせである。

マサイランド (Masai Land) はケニアとタンザニアの国境地帯のサバンナにある動物保護区と隣接する一帯で、遊牧民が居住している。家畜は単に財産として飼育し、経済生活上の積極的手段とはしない。彼等は農耕もほとんどしないし、家畜の代金で物資を購入することもしない。牛乳が普通の食事であるが、それに牛の血を混合すると腹もちがいいことを知っている。牛乳が食事の中心になることに変わりはないが、少量の穀類と野生の野菜と果物を取り入れている。

以上、5地域での一般的食品の配合例を挙げたが、果物と野菜を除いて、さまざまな食品が主食となっている。米であったり、バナナであったり、パンであったり、トウモロコシであったり、牛乳であったり、それぞれの地方産物中心の食事内容



TABLE 3 Nutritional intake by the farming tribes of Kikuyu and Luo per head for a meal

Menu	Food stuff	Material	Amount g	Calorie Cal	Protein g	Lipid g	Ca mg	Fe mg	Vitamin A I.U.	Vitamin B <sub>1</sub> mg	Vitamin B <sub>2</sub> mg	Nicotinic acid mg	Vitamin C mg	Remark
Menu A	Uji	96% ext. Maize meal	60	217	5.7	2.4	7.2	1.5	—	0.2	0.08	0.9	0	Breakfast of corn porridge
	Milk	Milk fresh	200	128	6.6	7.2	360	0.30	450	0.08	0.30	0.2	2.0	
	Sugar		20	80	0	0	0	0	0	0	0	0	0	
	Total		280	425	12.3	9.6	367.2	1.80	450	0.28	0.38	1.1	2.0	
Menu B	Ugali	96% ext. Maize meal	325	1,176	31	13	39	8.1	—	1.0	0.42	4.9	0	Ordinary lunch
	Milk	Milk fresh	150	96	5	5.4	180	0.15	225	0.06	0.23	0.15	1.5	
	Total		475	1,272	36	18.4	219	8.25	225	1.06	0.65	5.05	1.5	
Menu C	Irio	Maize green cobs	450	553	18	5.4	41	3.1	—	0.7	0.4	7.6	45	Lunch during corn season
		Peas	125	130	9	1.0	50	2.5	188	0.4	0.2	2	31	
		Potatoes	250	190	5	—	25	1.7	—	2.5	0.07	3.7	37	
		Pumpkin leaves	50	10	1	0.1	40	1.2	500	0.04	0.1	0.2	25	
	Total		875	883	33	6.5	156	8.5	688	3.64	0.77	13.5	138	
Menu D	Boiled Wheat	Wheat whole	200	688	23	4	60	7	—	0.8	0.2	10	—	School meal
	Milk Cow	Milk fresh	150	96	5	5.4	180	0.15	225	0.06	0.225	0.15	1.5	
	Cow Bone Soup		150	4.5	1	0.1	1.5	—	—	—	—	—	—	
	Total		500	788.5	29	9.5	241.5	7.15	225	0.86	0.425	10.15	1.5	
Menu C	Boiled Corns	Maize green cobs	600	738	24	7.2	54	4.2	—	0.90	0.30	10.2	60	Lunch during corn season
	Milk Cow	Milk fresh	150	96	5	5.4	180	0.15	225	0.06	0.23	0.15	1.5	
	Total		750	834	29	12.6	234	4.35	225	0.96	0.53	10.35	61.5	

		Supper											
		0	3.0	0.08	0.38	—	3.0	15	2.3	12	531	150	Rice
Menu D	Boiled Rice	—	—	—	—	—	—	—	—	—	—	—	—
	Stew	—	—	—	—	—	1.4	6	12.6	9	149	60	Meat cow
		—	—	—	—	—	0.4	24	—	0.6	20	60	Carrots
		1,800	2.7	0.12	0.09	1,000	2.5	80	0.3	2	28	100	Mixed leaves
		3.6	0.3	0.03	0.03	—	0.35	5	—	1	37	50	Potatoes
		15	0.5	0.20	0.08	—	0.25	15	—	0.8	24	50	Onion
		15	1.5	0.03	0.10	—	—	10	—	—	90	10	Oil
	5	0.15	0.01	0.02	—	—	155	15.2	25.4	879	480	Total	
	38.6	8.15	0.47	0.70	2,800	7.9	—	—	—	—	—	—	

である。総括的にいえることは内陸地ではタンパク源の豆や牛乳、肉類を求めなければならないし、都市では野菜や果物の摂取が必要である。

ガーナ、ケニアともに急激な都市化に伴って、食糧の確保から栄養問題に至るまで、多くの問題をかかえている。将来、食糧の流通がガーナ、ケニア全土に均一化され、主食はトウモロコシから米、小麦へ移行し、欧米なみにタンパク源が大量に消費されるようになるかもしれない。現時点においてガーナ、ケニア現地人の体格・体力は日本人と比較してすぐれた点もあるようであるが、食糧事情の変遷に伴って体格・体力がどのように推移するかは、今後の調査に多くの期待がかけられる。

## 5 Phenylthiocarbamide による味盲調査について

われわれは通常食物を眼と耳と鼻と舌とそしてふん囲気とで味わっている。(もっとも耳が食味に関係するところのごくわずかであるが)

これらの内で、舌は食味の判定に最も鋭敏で、生理的には味のある物質が水、唾液などに溶けて舌粘膜の乳頭部にある味蕾にふれて、神経を刺激して味の感覚が起こると考えられている。しかし、食物自体の側から見ても、調理、調味によってその呈味成分は変化を起こすし、それを受け入れるわれわれの身体の側から見ても季節や気候条件の変化、労働の種類、ひいては疲労の程度、健康状態、習慣や精神状態などによっても味覚や好みに変化を生ずることは常に経験するところである。

普通、純一な味としては、甘い、すっぱい、しおからい、苦いの四味が認められているが、この内で苦味は一般に好まれない味であるが、苦味を望む食品もある。たとえば、ビール、にがごりなどで、コーヒー、茶などにも明らかに苦味がある。

ここに少し述べてみたい事は、もっと根本的な事柄で、生れつき個人、個人の味覚に相当な差異があること、すなわち環境と無関係な遺伝性を持っているということである。

アメリカで家庭争議まで起こしたと言われる白

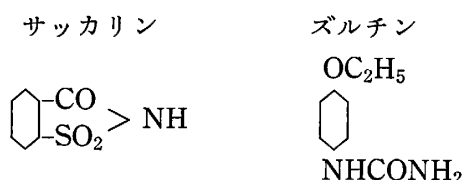
TABLE 4. Comparison of nutritional intake by per head for a day in Kenya and Japan  
(Results of calculation of nutritional intake by adults based on the menu of Table 3)

Meal time	Food stuff	Amount g	Calorie Cal	Protein g	Lipid g	Ca mg	Fe mg	Vitamin A mg	Vitamin B <sub>1</sub> mg	Vitamin B <sub>2</sub> mg	Nicotinic acid mg	Vitamin C mg
Breakfast	Uji											
	Milk											
	Sugar	280	425	12.3	9.6	367.2	1.8	450	0.28	0.38	1.1	2.0
Lunch	Irio	875	883	33	6.5	156	8.5	688	3.64	0.77	13.5	138
Supper	Boiled Rice											
	Stew	480	879	25.4	15.2	155	7.9	2,800	0.70	0.47	8.15	38.6
Snack	Pineapple	100	57	0.4	—	20	0.5	100	0.08	0.03	0.1	30
			2,244	71.3	30.3	698.2	18.7	* 4,038	4.70	1.65	22.85	208.6
Average for Japanese (1952)*			2,109	69.9	20.1	373	65	* 2,700	1.14	0.66	—	77
Average for Japanese (1968)*			2,253	77.1	44.6	530.5	—	1,420.9	1.10	0.96	—	96.1

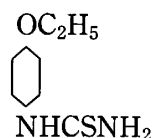
\* The source of data: Ministry of Welfare, Japan: Present state of national nutrition, 1968  
(Value per head for a day on a nationwide basis)

\* Carotene value shown in vitamin A value

色の結晶で、不思議な味を持っているパラエトオキシ・フェニール・チオカーバマイドの構造式は次に示すようにサッカリンやズルチンに近似であって、ことにズルチンとの相違点はわずかに CO の O を S でおきかえただけである。



パラエトオキシ・フェニール・  
チオカーバマイド



このパラエトオキシ・フェニール・チオカーバマイドをひたした紙片を用いてアメリカのブルークスリーが味覚の調査をして表5に示すような結果を得ている。

この成績からわかるように、同一種の純粋化合物に対して、ある者はたえがたい程のはげしい苦味を感じるのに、ある者はこれを甘く感じ、ある者はこれをすっぱく、またある者では味を感じていない。これは、はなはだ不思議なことであって、この味を感じない人を味盲と呼んでいる。

パラエトオキシ・フェニール・チオカーバマイドのエトオキシのないフェニール・チオカーバマイド(フェニール・チオ尿素):  $C_6H_5 NHCSNH_2$  も同じ目的に使用される。

フェニール・チオカーバマイド(PTC)の苦味をまったく感じない人がいるという事実は、1932

年 Fox によりすでに指摘され、続く多くの研究者により、これが劣性遺伝をすることが確立され、この味盲現象は遺伝学者により、人類遺伝解析の有力な手段として使われてきている。

ガーナ共和国における PTC 味覚調査は、海岸地帯の町ウィネバとケープコーストにある小学校、中学校、高等学校、大学に在席する児童、生徒、学生、622名(内男子366名、女子256名)について実施したが、味覚表現に確実性を欠く低学年児童は調査の対象からはずした。

PTC の1%エタノール溶液を東洋沱紙 No. 1(直径:12.5 cm)に含浸させ、一晚風乾し、1枚の円形沱紙を32枚の扇形に切ってそれを試験紙とした。この試験紙を舌の奥に十分にせるようにし、BITTER, SOUR, SALTY, SWEET, NO TASTE のいずれかを解答させた。その解答は現地語の通訳や表情、表現法を考慮して記録した。

ガーナ共和国の海岸地帯に分布する主要5部族の一つ FANTI はガーナ海岸線の中央部のマンケシムから内紛によって西部のセコンディに移動して、漁労に従事している部族である。GA-ADANGBE はナイジェリアのベニン古王国から13世紀末にガーナの海岸へ移住した者の子孫であるらしい。ASHANTI は近世までクマシにアシャンチ王国を誇り、ガーナを代表する部族である。EFUTU はウィネバ地区に居住し、漁労を営む部族である。EWE はガーナ共和国の東隣りのトーゴ共和国の主要部族であるが、第一次世界大戦でプロシアの敗北により、部族は英語圏、フランス語圏に二分され、第二次大戦後はガーナとトーゴの二カ国に分割されることとなり両国の国境地帯に多く居住するようになった。

ガーナ海岸西部の FANTI の PTC 無味者は4.5%で、ASHANTI の6.2%との間には  $\chi^2$  テス

TABLE 5 Taste threshold for Paraethoxy - Phenylthiocarbamide by paper method in American

Taste	Taster	Sweet	Bitter	Sour	Salty	Another taste	Non-taster
Actual Number	5,081	134	4,168	346	309	124	1,296
%	79.7	2.1	65.4	5.4	4.8	1.9	20.3

トにより有意の差があるとは認められないが、GA-ADANGBE の13.1%、EFUTU の18.1%、EWE の18.2%の三部族との間には1%から0.1%の危険率で有意の差が認められた。

海岸線西部の FANTI と ASHANTI が PTC 無味者の出現率において類似し、東部の GA-ADANGBE と EFUTU と EWE が類似していることは興味あることである。

被験者全員についてみると、PTC 無味者の出現率は10.9%で、男子では14.5%、女子では5.9%である。 $\chi^2$  テストにより男子と女子の間には5%の危険率で有意の差のあることが認められた。

ケニア共和国における PTC 味覚調査は、ナクル市近郊にある小学校、中学校、高等学校の児童、生徒、男子327名、女子255名、計582名について実施したが、方法ならびに判定などはガーナの場合に準じて行なった。

ナクル市周辺に居住する部族名を1962年に行なわれた国勢調査から拾ってみると、KIKUYU, LUO, LUHYA, KAMBA, KISII, MERU, KIJIKENDA, KIPSIGIS, NANDI, MASAI, その他となっており HUS の記載がない。JOY ADAMSON による The Peoples of Kenya にも HUS の記載は見当たらないようである。しかし、今次の調査で主要部族と少数部族の中間に HUS があり、これは各被験者の自称をそのまま記載したものである。

KAMBA の PTC 無味者の出現率は42.9%、KISII では20.0%、HUS では20.8%で、各部族間で $\chi^2$  テストを行なったところ KAMBA に対しては有意の差があるとは認められないが、MERU の4.3%、KIKUYU の9.0%、LUO の10.1%、LUHYA の12.2%に対しては0.1%あるいは1%の危険率で有意差が認められた。

被験者全員についてみるに、PTC 無味者の出現率は11.9%で、男子では13.1%、女子では10.2%である。 $\chi^2$  テストにより男子と女子の間に有意の差があるとは認められなかった。

前に述べたようにアメリカでは PTC に対する苦味者が65%、無味者が20%であるが、この割合は他の人種にあってはどうであろうか。

まず、日本人についての田中義磨の報告によると、アメリカ人に比べて苦味者が著しく多く無味者が少ない。すなわち、各地での調査結果を略述すると（括弧内は無味者の百分率）、松本では83.3%（13.9%）、諫早では82.6%（14.4%）、米子では83.8%（12.5%）、三島では85.6%（9.8%）、札幌では84.8%（9.4%）、小樽では87.4%（8.4%）、これらを平均すると84.6%（11.4%）である。

また、沢田芳男が熊本県下に在住している男子3,159名と女子1,579名（この内247名は佐賀県に在住）の計4,738名（年齢は6歳から75歳まで）について調査した結果では苦味者83.3%、無味者12.1%である。

なお、台湾生蕃は蕃社によって非常に異なるが、無味者の割合はブヌン族の6.5%を最高とし、ツォウ族の0.35%が最低で、平均は1.8%、北海道の日高アイヌでは無味者が4.6%、朝鮮人の資料では苦味者81.0%、無味者12.2%、福州系中国人では苦味者89.5%、無味者7.1%という記載がある。

Ademar と Antonio はブラジルの Parana 地方における味盲の出現率は26%、Sao Paulo 地方の日本人移民の子孫では8.99%、Bahia 地方では38%の味盲の頻度があり、人種による差を明らかにしている。このように無味者の比率は民族的に顕著なる差が認められるようである。

## 6 ミミアカの乾・湿性状調査について

ミミアカ（耳垢）の説明に、ミミアカの多型とその生物学的意義と題する松永 英の総説を引用すると、ミミアカにはドライとウェットの2型があつて、その分布は人種によって違い、遺伝的な多型現象を示し、耳道腺の分泌物であるミミアカの性状は、体に広く分布しているアポクリン腺と同じ遺伝子の支配を受けていて、体質的なものだとしている。

ミミアカは灰白色でカサカサに乾いていて、鱗屑状になっている乾型またはドライと呼んでいる型と、褐色でネバネバした、あめ状をしている湿型またはウェットで、俗にアメミミ、アブラミミなどといわれる2種類の型に分けることができる。

ガーナ共和国におけるミミアカの性状調査は、ウィネバとケープコーストにある小学校、中学校、高等学校、大学に在席する児童、生徒、学生、男子682名、女子527名、計1,209名について懐中電灯で両側の外耳道を観察し、乾型、湿型を判定した。

湿型の出現率は男子49.0%、女子67.2%、全体では56.9%である。男子と女子の間には、 $\chi^2$ テストにより0.1%の危険率で有意の差が認められた。

部族別に男子と女子の湿型の出現率について $\chi^2$ テストを行なったところ、FANTIの男子54.9%、女子71.5%の間に0.1%、GA-ADANGBEの男子44.7%、女子73.6%の間に0.1%、OTHERS(ウィネバ地区とその周辺に居住する少数部族)の男子38.5%、女子69.0%の間に1%の危険率で、それぞれ有意の差が認められた。ASHANTI, EFUTU, EWE, AKWAPIM, KWAHU, AKYEMについては男女の間に湿型の出現率に有意の差があるとは認められなかった。

EFUTUはウィネバ地区に居住しているが、湿型の出現率は27.0%と低く、他の部族との間に有意の差が認められた。OTHERSの湿型の出現率は46.7%で、この出現率に比較的近い出現率を示した部族にGA-ADANGBEの56.7%、EWEの53.8%、AKYEMの51.7%がある。

ケニア共和国におけるミミアカの性状調査は、ナクル市近郊にある小学校、中学校、高等学校の児童、生徒、男子807名、女子636名、計1,443名について実施した。方法ならびに判定はガーナの場合に準じて行なったが、湿型の出現率は男子86.6%、女子87.7%、男女の平均では87.1%で、 $\chi^2$ テストにより男子と女子の出現率の間に有意の差があるとは認められなかった。また部族毎の男子と女子の湿型出現率を $\chi^2$ テストによって比較検定を試みたが、有意の差があるとは認められなかった。

各部族間のミミアカ湿型の出現率を $\chi^2$ テストにより検定したところ、MERUの69.6%はKIKUYUの87.2%、LUOの88.1%、LUHYAの88.7%に対して有意の差が認められた。

日本の周辺の人種集団および他の人種集団につ

いて調べられた成績についての松永 英の記載では、北支那人、韓国人は4~8%と低く、ツングースやモンゴル族では10%前後で、これに日本人が続いている。日本人での湿型の頻度をみると、地域によって最低12%から最高22%くらいまでの幅があるが、18~19%程度に報告されたものが一番多いと述べている。これまでに調べられた資料を合計すると被験者総数23,417人のうち湿型は3,810人で16.3%になるとのことである。南支那人、琉球島人では26~38%と高く、海南島黎族では55%、ミクロネシア人では63%、台湾高砂族、メラネシア人では70%以上に昇っている。アイヌ人は87%と高く日本人の16%との間には大きなひらきのあることが認められる。最後にドイツ人、米国人白人になると97%前後ときわめて高く、米国人黒人では90.5%にも達している。なお、現在の米国人黒人には白人の遺伝子が平均して約3分の1まざっていると考えられるから、アフリカの黒人ではその100%が湿型と思われると述べているが、われわれのガーナでの調査では56.9%、ケニアでの調査では87.1%の湿型頻度であった。このことについては、今後さらに調査を続けてみたい。

私は、われわれの今回の調査から、次のことを提言しておきたい。

まず、第1は、物質にめぐまれた最近の日本の子供の体格は向上しているが、体力は必ずしもそれに伴っていないということである。ある時期、ある年齢などで体力の向上がみられるようなことがあったとしても、それは単なる早熟現象を示しているに過ぎないということである。

第2は、機械文明の発達には体を段々使わない方向に仕向けていて、この近代文明の所産が日本の子供達の体格と体力のアンバランスを引き起こす大きな原因につながっているように思えるということである。

第3は、これからの日本の子供の健康ならびに体力上の不安を克服するには、適切な身体運動が一つの方法として考慮されねばならないということである。

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INVESTIGATIONS OF PHYSIQUE, PHYSICAL PERFORMANCE,  
PHYSICAL CONSTITUTION AND DIETARY LIFE  
CONDUCTED BY KUMAMOTO UNIVERSITY  
SCIENTIFIC EXPEDITION FOR AFRICAN  
PHYSICAL CONSTITUTION

YOSHIO SAWADA<sup>1</sup>

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This article is an abstract of the special paper (entitled KUMAMOTO UNIVERSITY'S SCIENTIFIC SURVEY REPORT ON THE CONSTITUTION OF AFRICAN LOCAL PEOPLE — "ON BIOLOGICAL INDIVIDUALITY OF AFRICAN PEOPLE" —) read at the 14th annual

meeting of the Japanese Society of Tropical Medicine held in Nagasaki, Japan, on November 27 and 28, 1972.

The First Kumamoto University Team<sup>2</sup> for scientific survey of African physical constitution conducted investigations in Ghana of the West Africa and Kenya of the East Africa from early September to early December 1971.

One of the reasons for our selection of the African local people as the object of our somatological study is that though there are a number of races quite different in modes of living and character in Africa, their morphological or functional characteristics are deemed to be kept in a pure form in the environments involving no industrial pollution and therefore, we desired to secure and keep a variety of data concerning physique, physical performance and physical constitution of the African local people at the present time.

All the members of the team would like to take this opportunity to express their deep gratitude to a number of individuals and organizations of Ghana, Kenya and Japan for valuable help and encouragement. In particular, financial supports given by the Governments of Japan are gratefully acknowledged.

In view of the results of our survey made at this time, the following summary comments can be made:

Firstly, though physique of the Japanese boys and girls being materially under a favorable situation in recent years has improved, it is not always accompanied with physical fitness. Even if there are improvements in physical fitness at certain time and age, etc., they indicate merely a premature phenomenon.

Secondly, the development of mechanical civilization is bringing about a trend towards less use of body and such outcome of civilization seems to be serving as a great cause to bring about unbalance between physique and physical fitness of the Japanese children.

Thirdly, as one of the means to overcome apprehensions about health and physical fitness of the Japanese children in future, an induction of stimulation of the autonomic nerve system through physical exercise is believed to be an appropriate method.

At the same time, it is advised that one should not be swept away by the present environment, but should progressively control it. In other words, it is proposed that one be a wild man in the body and be a civilized man in the brain.

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## STUDIES ON PHOSPHOLIPASE A IN *TRIMERESURUS FLAVOVIRIDIS* VENOM

### I. The rapid assay method and egg yolk clearing action of phospholipase A

HIROSHI KIHARA

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**Abstract:** G. V. Marinetti has reported phospholipase A of snake venom to cause clearing of a suspension of egg yolk. Based on this fact the rapid and convenient assay method for phospholipase A has been studied. The present assay method is affected by various factors such as pH, ion and ionic strength of the reaction mixture, but under well controlled conditions it is useful and highly sensitive. This method, however, has a disadvantage that the standardization of the assay unit during the long course of the test is very difficult.

Recently, the studies on phospholipase A [EC 3.1.1.4] in various kinds of snake venoms have been reported (Augustyn and Elliott, 1970, Kawauchi *et al.*, 1971, Maeno *et al.*, 1962, Salach *et al.*, 1971, Setoguchi and Ohbo, 1969, Wu and Tinker, 1969, and Wells and Hanahan, 1969). In these studies isolated phosphatides such as phosphatidylcholine and -ethanolamine or mammalian red cells have been used as the substrate for phospholipase A assay.

G. V. Marinetti (1961, 1965) has reported snake venoms to cause clearing of a suspension of egg yolk. This clearing is due to phospholipase A acting on the lipoproteins to produce lysolecithine, which is capable of solubilizing the egg yolk suspension. The present communication describes the rapid assay method for phospholipase A based Marinetti method with some modifications.

#### MATERIALS AND METHODS

**Habu venom:** Lyophilized Habu (*Trimeresurus flavoviridis*) venom was kindly supplied from the Pharmaceutical & Survey Section of the Sanitation Division, Kagoshima Prefecture, Japan.

**Egg yolk clearing assay:** The assay method used was similar to that of Marinetti. In a typical experiment, fresh hen egg yolk was used a 5-fold dilution with 0.1 M phosphate buffer (pH 7.0) and centrifuged for 20 min with the speed of 7,500 rpm (rotor No. 4, Kubota, Japan) at 4 C. The supernatant was able to keep as a stock solution at 4 C for a week without any essential change of the activity. This working suspension was prepared for the assay by a 100-fold dilution of the stock solution with

distilled water, which gives an absorbancy at 510  $m\mu$  of 1.0 to 1.5. The reaction was initiated by addition of 1 to 20  $\mu l$  of the enzyme solution into 3 ml of the working suspension in a cell of 1 cm light path and was followed by the decrement of OD at 510  $m\mu$  with a spectrophotometer (Shimazu QV-50, Japan) at 25 C. After completion of the clearing reaction, the time (sec),  $\tau$ , required to reach the half value of the total net decrement of the turbidity was estimated. The activity was expressed as  $1/\tau \times 1,000$ .

## RESULTS

### 1. Effect of solvent on egg yolk suspension

The state of egg yolk suspension is affected by various factors such as pH, ion and ionic strength of the solvent. To find a suitable solvent which keeps the lipoproteins as stable emulsion, the fresh egg yolk was diluted to 5-fold with three kinds of solvent, 0.9% NaCl, 0.1 M phosphate buffer (pH 7.0) and distilled water. In each case, the working suspension was prepared by diluting 100-fold with distilled water.

The original turbidity of the suspension was decreased in the order of 0.9%

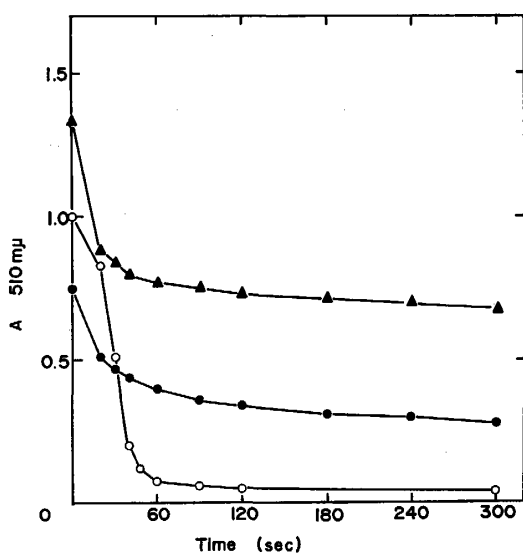


Fig. 1 Effect of solvent on egg yolk suspension. Egg yolk clearing action was tested on the egg yolk suspension of different solvent. 50  $\mu l$  of 0.1% crude venom was used for the working suspension of 0.9% NaCl and distilled water, respectively, and 5  $\mu l$  was used in the case of 0.1 M phosphate buffer (pH 7.0).  
 —▲—: 0.9 % NaCl  
 —●—: distilled water  
 —○—: 0.1 M phosphate buffer (pH 7.0)

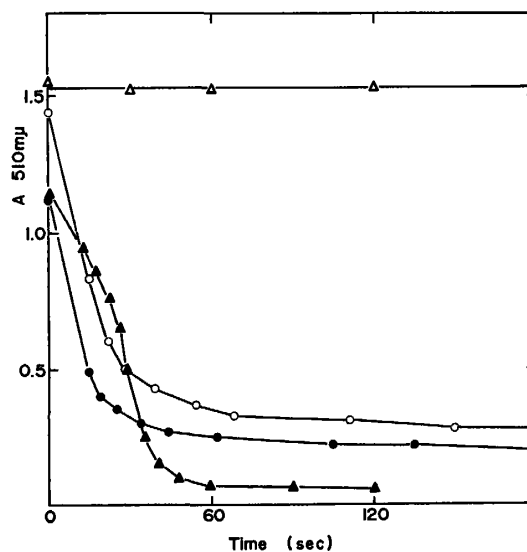


Fig. 2 Effect of pH on egg yolk suspension. On the working suspensions made from different pH of 0.1 M phosphate buffer extracts of egg yolk, 5  $\mu l$  of 0.1% crude venom were added, respectively.  
 —△—: pH 5.6, —▲—: pH 7.0,  
 —○—: pH 8.0, —●—: pH 9.1

NaCl, 0.1 M phosphate buffer (pH 7.0) and distilled water. However, the net decrement of the turbidity caused by the enzymic action was decreased in the order of 0.1 M phosphate buffer (pH 7.0), 0.9% NaCl and distilled water (Fig. 1). It is emphasized that the amount of the enzyme used in the case of phosphate buffer was one-tenth of other two cases. These results indicate that the lipoproteins accessively to phospholipase A can be extracted effectively and exist as a stable emulsion in 0.1 M phosphate buffer (pH 7.0).

## 2. Effect of pH and ionic strength

The pH of the 0.1 M phosphate buffer which is used for initial 5-fold dilution of egg yolk was varied as follows, pH 5.6, pH 7.0, pH 8.0 and pH 9.1. The original turbidity was decreased by increasing the pH. Therefore, the working suspension of alkaline side, pH 8.0 and pH 9.1, were prepared by diluting 14-fold with distilled water and 100-fold dilution of pH 7.0 and pH 5.6. Using 5  $\mu$ l of 0.1% crude Habu venom the clearing actions were followed (Fig. 2).

At pH 5.6, no decrement of the turbidity is observed for 3 min. This result shows no lipoproteins accessible to phospholipase A exist as a stable emulsion at acidic

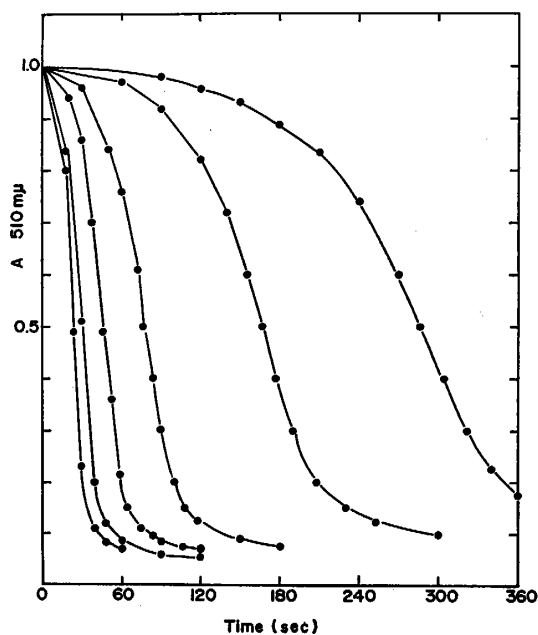


Fig. 3 Effect of enzyme concentration.

The time courses of egg yolk clearing action were followed on the working suspension, made from 0.1 M phosphate buffer (pH 7.0) extract of egg yolk, with various amounts of crude venom. From left to right, 0.2, 0.5, 1.0, 2.0, 5.0 and 10.0  $\mu$ g of crude venom.

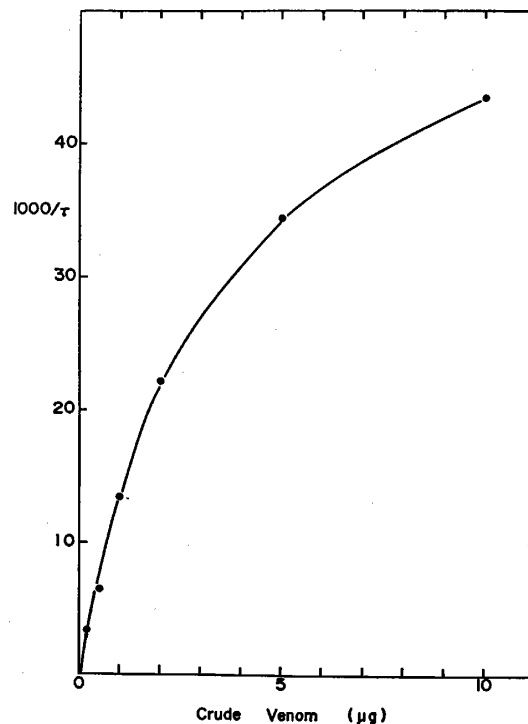


Fig. 4 Relationship between  $1/\tau \times 1,000$  and the amounts of crude venom.

The figure was rewritten from the data of Fig. 3.

pH. It is also interesting that at alkaline pH a lag phase is not observed.

The effect of ionic strength was also studied varying the concentration of the phosphate buffer (pH 7.0). The original turbidity was decreased linearly with increasing the concentration of phosphate buffer from 1.0 to 40 mM (final concentration in the working suspension).

### 3. Effect of enzyme concentration

The effect of the concentration of crude Habu venom varying 0.2 to 10  $\mu\text{g}$  is shown in Figs. 3 and 4. Considering the above results, the working suspension was prepared from the 5-fold dilution of egg yolk with 0.1 M phosphate buffer (pH 7.0).

At early stage of the reaction, a lag phase is observed, as observed by Marinetti (Fig. 3). Marinetti defined the turbidity decrement of initial 10 minutes measured at 925  $\text{m}\mu$  as a relative activity. In the present system, it is very hard to find a relationship between the turbidity decrement and enzyme concentration. Then the reciprocal of the time (sec),  $1/\tau$ , required to reach the half value of the net turbidity decrement and versus enzyme concentration were plotted (Fig. 4). The linear relationship is found between  $1/\tau \times 1,000$  and enzyme concentration of 0.2 to 1.5  $\mu\text{g}$ . Although this method has a disadvantage of having to follow the complete reaction time course, the error coming from the initial unstable decrement of turbidity might be eliminated.

## DISCUSSION

The present studies show that phospholipase A in Habu venom can rapidly hydrolyze the egg yolk lipoproteins. According to the present assay method of egg yolk clearing, phospholipase A activity can be measured with crude venom of less than 1  $\mu\text{g}$ . In contrast, Marinetti method requires 10 to 100  $\mu\text{g}$  of crude venom for an assay. Because of this high sensitivity of the present method, artificial contamination of the detergent which is used for washing of glasswares should be carefully avoided. This method, however, has a disadvantage that the standardization of the assay unit during the long course of the test is very difficult, due to the differences of eggs. Under well controlled conditions, this assay method is useful for the detection of phospholipase A as demonstrated in the present studies.

Concerning the state of lipoproteins in egg yolk, the stock solution of egg yolk in 0.1 M phosphate buffer (pH 7.0) was gelfiltrated on the Sephadex G-100 column, equilibrated with 0.1 M phosphate buffer, before and after the treatment with the purified phospholipase A. Two peaks emerged but no significant differences have been observed in these chromatographies. Marinetti (1965) also observed no differences in his system. This result indicates that phospholipase A simply acts on phosphatides of lipoproteins and has no effect on the interaction between lipoproteins.

## ACKNOWLEDGEMENTS

The author is indebted to Drs. I. Kato, N. Tominaga, H. Fukushima, F. Ohbo and M. Yaita for their encouragements and valuable advices during this work. The

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### *Trimeresurus flavoviridis* 毒中の phospholipase A の研究

#### I. phospholipase A の分析法と卵黄透明化作用

木 原 大

蛇毒の phospholipase A が卵黄を透明化させる性質を利用して、同酵素の活性測定法について実験を試みた。実験は卵黄の抽出溶媒, pH, イオン強度および酵素濃度等について試み, その結果市販新鮮卵黄を 0.1 M リン酸緩衝液 (pH 7.0) で 5 倍稀釈後, 不溶物を遠心除去したものを保存液とする。測定はこの保存液を蒸留水で 100 倍稀釈し  $10^{-4}$  M になるように  $\text{Ca}^{++}$  を加え, 同溶液 3 ml あたり 1~10  $\mu\text{l}$  の酵素溶液を加え, 510 m $\mu$  の吸光度減少を測定し, 全濁度減少量の 1/2 に達する時間 (秒) の逆数が酵素量と直線関係にあることが明らかになった。

また卵黄中のリポプロテインについて同酵素の処理を受けたものと, 受けないものについてゲル透過を行ったが何ら差違は認められず, 同酵素は卵黄中のリポプロテインのリン脂質部分にのみ作用し, リポプロテイン間には影響をおよぼさないものと考えられる。

## STUDIES ON PHOSPHOLIPASE A IN *TRIMERESURUS FLAVOVIRIDIS* VENOM

### II. Purification and some properties of phospholipase A

HIROSHI KIHARA

Received for publication 11 March 1974

**Abstract:** Phospholipase A [EC 3.1.1.4] was purified from the venom of Habu (*Trimeresurus flavoviridis*) by the gel filtration on Sephadex G-100 and the column chromatographies on CM-cellulose, with a 3.7% over-all yield and a 7.1-fold increase in the specific activity. The purified enzyme was proved to be homogeneous by the disc electrophoresis. And the gel filtration on a Sepharose 6B column of the purified enzyme indicated a molecular weight of around 26,000. The purified enzyme was caused immediate loss of the activity by the addition of EDTA. But the activity was recovered by the addition of excess  $\text{CaCl}_2$  in the presence of EDTA and no activity was recovered by the addition of  $\text{Mg}^{++}$ ,  $\text{Cd}^{++}$  and  $\text{Zn}^{++}$ , respectively, in the place of  $\text{Ca}^{++}$ .

Recently, the purification of phospholipase A from snake venoms (Wu and Tinker, 1969, Salach *et al.*, 1971, Wells and Hanahan, 1969, Kawachi *et al.*, 1971, Augustyn and Elliott, 1970, Setoguchi and Ohbo, 1969 and Maeno *et al.*, 1962) and porcine pancreatic juice (Haas *et al.*, 1968) have been reported with extensive characterization.

I have tried to isolate and characterize this enzyme in Habu venom. The enzyme preparation purified by the use of Sephadex G-100 gel filtration and CM-cellulose column chromatography was homogeneous in disc gel electrophoresis.

In this communication, the results of chromatographic purification of phospholipase A and its some properties in Habu venom are described.

#### MATERIALS AND METHODS

**Habu venom:** Lyophilized Habu venom was kindly supplied from the Pharmaceutical & Survey Section of the Sanitation Division, Kagoshima Prefecture, Japan.

**Phospholipase A activity:** The assay was performed by using the egg yolk suspension as the substrate and measuring the decrement of the turbidity as described in the previous paper (Kihara).

**Hemolytic activity:** The reaction mixture is as follows; 3 ml of 40-fold diluted rabbit red cells suspension in 0.9% NaCl, 1 ml of 0.1 M phosphate buffer (pH 7.0), 0.2 ml of egg yolk suspension (5-fold diluting egg yolk in 0.05 M phosphate buffer was made 20-fold dilution with 0.9% NaCl and centrifuged), 0.1 ml of 10 mM

CaCl<sub>2</sub> and 20  $\mu$ l of the enzyme solution. After the reaction for 15 min at 37 C, the reaction mixture was immediately centrifuged and the absorbancy at 550 m $\mu$  of the supernatant was measured.

Column chromatography: All column chromatographies were carried out at room temperature with the eluent containing 1.0 to 100  $\mu$ M CaCl<sub>2</sub>. Sephadex G-100 (Pharmacia) and CM-cellulose (Serva) were washed and activated by the way recommended by the manufacturers. In both cases, ammonium acetate was used as eluent. The gradient elution was performed lineally with two chambers system (1,000 ml each). The fractions were desalted through thrice lyophilization.

Disc electrophoresis: 100 and 200  $\mu$ g of purified enzyme were subjected to gel electrophoresis using 7% acrylamide and the pH 4.0 system of Reisfeld *et al.* (1962). Protein in the gel was stained with amido black 10B.

Molecular weight determination: Sepharose 6B (Pharmacia) column was well equilibrated with the buffer of 0.1 M sodium acetate containing 0.1 M KCl. The run was carried out at room temperature. Thrice crystallized chymotrypsin and trypsin were purchased from Washington Biochem. Corp., USA. Taka-amylase A (TAA) and ovinhibitor were prepared by the method of Akabori *et al.* (1951) and Davis *et al.* (1969), respectively.

## RESULTS

### 1. Column chromatography of Habu venom

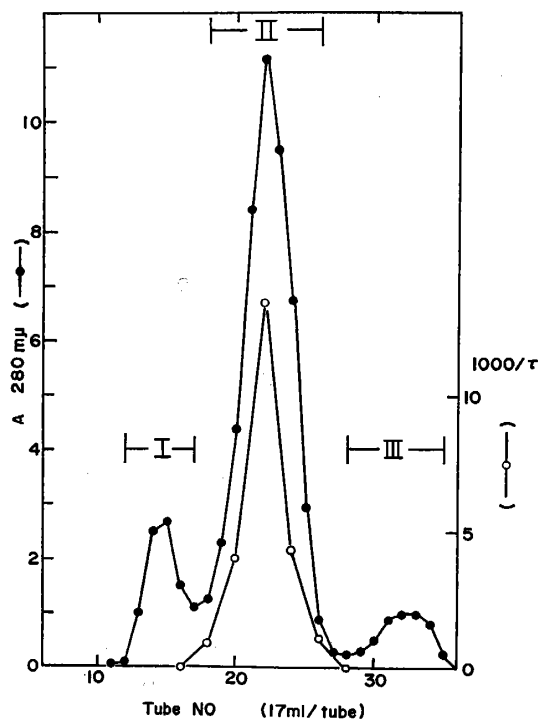


Fig. 1 Gelfiltration of crude Habu venom on Sephadex G-100 column. The column (3.3 $\times$ 50 cm) was equilibrated with 0.1 M ammonium acetate containing 1  $\mu$ M CaCl<sub>2</sub>. 1,000 mg of crude venom was dissolved in 7 ml of 0.1 M ammonium acetate and applied on the column. The activity was measured by using 5  $\mu$ l from a tube.  
 —●—: A. 280 m $\mu$ , —○—: the enzyme activity

Crude Habu venom solution in 0.1 M ammonium acetate containing  $1 \mu\text{M}$  of  $\text{CaCl}_2$  was gel filtrated on Sephadex G-100 and fractionated into three peaks, I, II and III (Fig. 1). Egg yolk clearing action was tested using  $5 \mu\text{l}$  of each tube and found in peak II. After the lyophilization of the peak II, it was applied on Sephadex G-75 ( $3.3 \times 42 \text{ cm}$ ) but no more resolution was obtained.

The lyophilized peak II of Sephadex G-100 filtration was further purified on a CM-cellulose column and was fractionated into nine components by the linear gradient elution with ammonium acetate containing 0.1 mM of  $\text{CaCl}_2$  (Fig. 2). Egg yolk clearing action was found in the peak III. The negligible amount of the activity was also observed at the tail of the peak II.

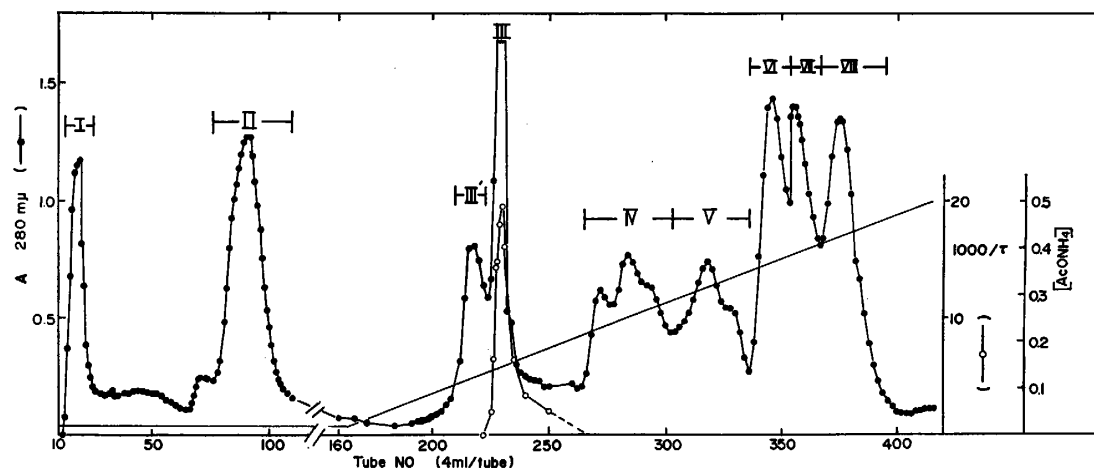


Fig. 2 CM-cellulose chromatography of the peak II in Sephadex G-100 chromatography. The column ( $1.5 \times 92 \text{ cm}$ ) was equilibrated with 0.02 M ammonium acetate containing 0.1 mM  $\text{CaCl}_2$  and 790 mg of the gelfiltrated sample was dissolved in 20 ml of the first buffer. Linear gradient elution was performed from 0.02 to 0.5 M of ammonium acetate. The activity was measured by using 1 to  $2 \mu\text{l}$  of 10-fold dilution of the fraction.

—●—: A. 280  $m\mu$ , —○—: the enzyme activity

The peak III was rechromatographed on the CM-cellulose column with the same buffer system used in the first chromatography (Fig. 3).

By these chromatographies, approximately 7-fold purification has been achieved (Table 1).

## 2. Hemolytic activity of egg yolk clearing factor

The egg yolk clearing action has been already proved to be an action of phospholipase A which produce lysolecithin from egg yolk lipoproteins (Marinetti, 1961, 1965). The present results of the chromatographic purification of egg yolk clearing factor in Habu venom confirmed again that the egg yolk clearing action was not due to an artifact but the enzymatic action. This was further confirmed by measuring the hemolytic activity (Maeno *et al.*, 1962). Hemolysis of rabbit red cells was observed only at the position of the peak III of CM-cellulose chromatography which



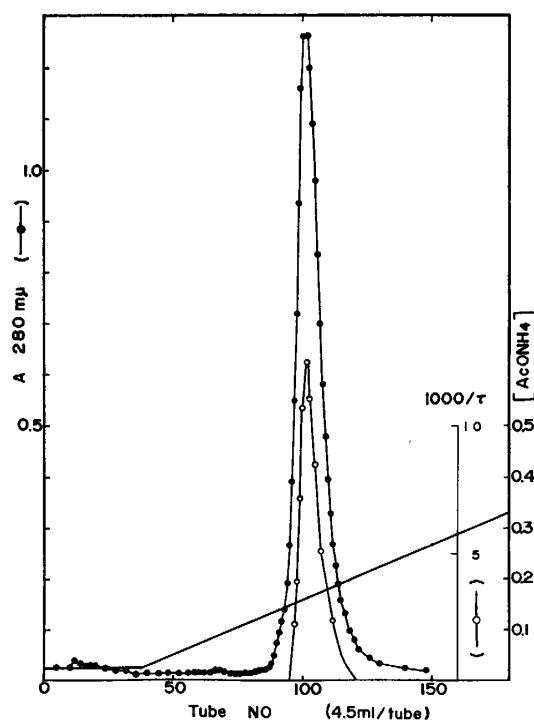


Fig. 3 The peak III in the CM-cellulose chromatography was rechromatographed. The column (1.6×39 cm) was equilibrated and eluted with the same buffer system in the first chromatography (Fig. 2). 37 mg of the peak III in 7 ml of 0.02 M ammonium acetate was applied on the column. The enzyme activity was observed by measuring the egg yolk clearing activity.

—●—: A. 280 m $\mu$ , —○—: the enzyme activity

TABLE 1 Summary of purification of phospholipase A

Step	Protein		Specific Activity <sup>1)</sup>	
	Total (mg)	Recovery (%)	(Units/A <sub>280m<math>\mu</math></sub> )	Rel. to venom
Crude venom	1000	100	11.8	1.0
Sephadex G-100	790	79	19.1	1.6
CM-cellulose (1st)	60	6	63.6	5.4
CM-cellulose (2nd)	37	3.7	83.9	7.1

1) The assays were performed with the presence of 50 mM CaCl<sub>2</sub>

showed the egg yolk clearing action.

### 3. Gel filtration of purified phospholipase A

To determine the apparent molecular weight of the purified phospholipase A, only a single band was shown by the disc electrophoresis (Fig. 4), it was gel filtrated on a Sepharose 6B column with four different proteins (chymotrypsin, mol wt 26,000, trypsin, mol wt 24,000, TAA, mol wt 51,000, ovoidin, mol wt 48,000, ovo-

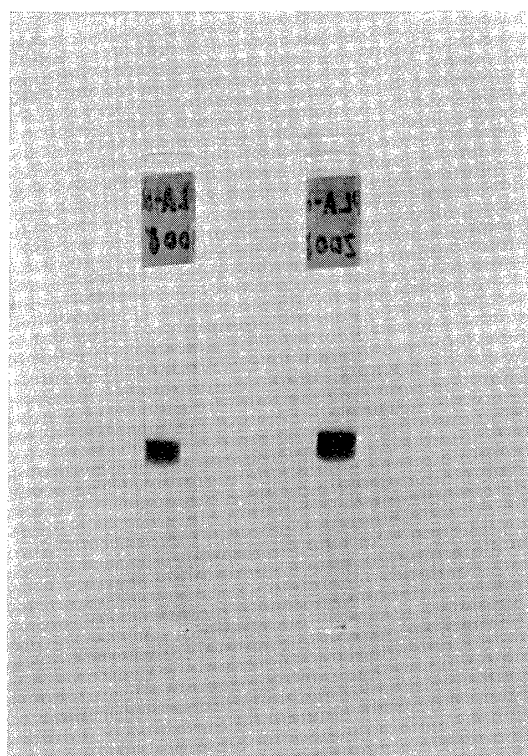


Fig. 4 Disc electrophoretic pattern of the purified enzyme.

100 and 200  $\mu\text{g}$  of purified enzymes were applied to gelelectrophoresis using 7% acrylamide and the pH 4.0 buffer system. An electric current of 3 mA per tube applied for 2 hr. Protein in the gel was stained with amido black 10B.

left: 100  $\mu\text{g}$ , right: 200  $\mu\text{g}$

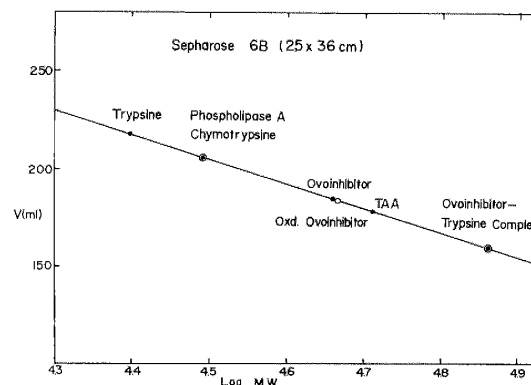


Fig. 5 Estimation of molecular weight of phospholipase A.

Molecular weight determination of purified phospholipase A was made by gel-filtration on a Sepharose 6B column. Details of the chromatographic procedure were described in the experimental section of the text.

inhibitor-trypsin complex, mol wt 72,000) serving as standard. The enzyme from Habu venom was eluted at nearly the same position of chymotrypsin, indicating a molecular weight of around 26,000 (Fig. 5).

#### 4. Effect of Metals and EDTA

10 ml of the purified enzyme was dialyzed against two liter of distilled water for 20 hours at 4 C and used to test the effect of metals and EDTA on the enzyme. No dialysis and EDTA treatment of the egg yolk emulsion was done. Only the enzyme solution was preincubated with EDTA or metals and used for the assay. These results are summarized in Table 2.

The incubation of the enzyme at room temperature with 20 mM EDTA of pH 6 caused immediate loss of the activity. But the activity was recovered by the addition of excess  $\text{CaCl}_2$  (50 mM) in the presence of 10 mM of EDTA. No activity was recovered by the addition of  $\text{Mg}^{++}$ ,  $\text{Cd}^{++}$  and  $\text{Zn}^{++}$ , respectively, in the place of

TABLE 2 Effect of metals and EDTA

Sample	Conc. <sup>1)</sup> (mM)	Specific Activity	Rel. to Activity
1. Dialyzed and lyophilized	—	14.8	1.0
2. EDTA into Samp. 1	20	0	0
3. CaCl <sub>2</sub> into Samp. 2	50	15.0	1.01
4. MgSO <sub>4</sub> , CdSO <sub>4</sub> , and ZnSO <sub>4</sub> into Samp. 2	50	0	0
5. CaCl <sub>2</sub> into Samp. 1	50	47.0	3.17
	75	66.0	4.46

1) The concentration of ions in the enzyme solution used for the assays.

Ca<sup>++</sup>.

These results show this enzyme specifically require the calcium ion as observed in the other phospholipase A of different sources. The addition of CaCl<sub>2</sub> to the dialyzed enzyme without EDTA showed a considerable enhancement of the activity, approximately 3 to 4-fold.

#### DISCUSSION

The specific activity has been increased to 7-fold by gel filtration and subsequent CM-cellulose column chromatographies. This degree of the purification is not so high compared with that of *C. atrox* (Wu and Tinker, 1969) but similar to that of *C. adamanteus* (Wells and Hanahan, 1969). The behavior on CM-cellulose may indicate the enzyme in Habu venom is a weak basic protein.

The activity of the enzyme was easily lost by the presence of EDTA and recovered by adding excess calcium ion. This result agrees with the early observation on the partially purified enzyme of Habu venom by Maeno *et al.* (1962).

The apparent molecular weight of phospholipase A from Habu venom is about 30,000, which is similar to that of *C. adamanteus* (Wells and Hanahan, 1969). There seems to be two types of phospholipase A, the one of low molecular weight around 15,000 [*C. atrox* (Wu and Tinker, 1969), porcine pancreas (Haas *et al.*, 1968) and a sea snake (Setoguchi and Ohbo, 1969)] and the other of relatively high molecular weight about 30,000 (*C. adamanteus* and Habu).

Wells and Hanahan (1969) isolated two forms of phospholipase A from *C. adamanteus*. In Habu venom another form of the enzyme was also observed in the tail of the peak II in the CM-cellulose column chromatography, but the amount and its specific activity were negligibly low.

#### ACKNOWLEDGEMENT

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*Trimeresurus flavoviridis* 毒中の phospholipase A の研究

## II. phospholipase A の精製と二, 三の性質

木 原 大

ハブ粗毒を Sephadex G-100 でゲル濾過して 3 分画を得, phospholipase A は分画 II に存在した。この分画を脱塩, 乾燥後 CM-セルロース・カラムにかけて直線グラディエント法でイオン交換クロマトを行い, 分画 III に phospholipase A 活性が認められた。この分画を同条件で再クロマトし活性と一致した単一のピークが得られた。このピークは溶血活性とも一致した。

本標品の純度はアクリルアミドの pH4.0 ゲルを用いたディスク電気泳動で単一であることが証明された。分子量は Sepharose 6B を用いたゲル濾過分析法で, キモトリプシンとほぼ同位置に溶出され約 26,000 と推定された。

また本酵素と金属イオンとの関係は他の起源からの酵素とどうよう EDTA を加えられると直ちにその活性を失い, 過剰の  $\text{Ca}^{++}$  を加えると EDTA 存在下でもその活性をとりもどす。しかし  $\text{Mg}^{++}$ ,  $\text{Cd}^{++}$  あるいは  $\text{Zn}^{++}$  では活性は回復しなかった。また通常他の蛇毒で報告されているアイソザイムはハブ毒では認められなかった。この酵素の回収率は粗毒の 3.7% で, 比活性の上昇は 7.1 倍であった。

## EPIDEMIOLOGICAL STUDIES ON ROBLES' DISEASE (AMERICAN ONCHOCERCIASIS) IN GUATEMALA

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**Abstract:** In order to clarify the present situation of endemic onchocerciasis in Guatemala, the authors carried out epidemiological studies in several endemic areas during the period between Nov. 1973 and Jan., 1974. The microfilaria positive rates for Fincas Monte de oro, Nimaya and Milan were 58.5%, 67.6% and 46.1%, respectively. There was a definite difference in the rate of onchocercal infection between males and females. In male children, the microfilaria positive rate was much higher than in corresponding females, probably due to their living habits. Onchocercomatas were frequently found in younger persons and it was noted that half of the nodules found in the inhabitants in Finca Nimaya were located in the iliac region. In 3 Fincas, the vector black flies were captured using human baits at different times of the day; the flies were most actively biting between 0900 and 1500 hours. Among the flies collected, *S. ochraceum* was the most dominant species, and the rest included *S. metallicum*, *S. callidum* and *S. exiguum*. There was no relationship between microfilaria densities in infected persons at different times of the day and the biting density of *S. ochraceum*. It was shown that approximately one-half of the captured flies were caught on the lower part of the body. Four microfilaria positives were examined with Mazzotti test. In this brief survey, it is concluded that *O. volvulus* is still actively transmitted in endemic foci in Guatemala.

### INTRODUCTION

American onchocerciasis, known as Robles' disease, was discovered in 1915 by a Guatemalan doctor, Rodolfo Robles (1919). After seeing hundreds of cases he arrived at the conclusion that onchocerciasis was a blinding disease. Pacheco Luna (1918) made the first classical description of the several disorders of the eyes produced by onchocerciasis. Calderon (1921, according to Estevez 1921) found for the first time developing larvae in the thoracic muscles of the Guatemalan black flies which were not well known at that time.

Since the discovery of the disease, sporadic trials of treatment with some drugs were carried out, and thereafter they were abandoned because of their inefficacy or dangerous side effects. The only treatment given to patients with Robles' disease is the one proposed and used by Robles, the extirpation of the nodules. However, this procedure has not decreased the prevalence and transmission of onchocerciasis. On the contrary, it seems that the infection rate in endemic zones has increased or at

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least remained stationary. Some Fincas (plantations) that were visited every six months by denodulization brigades have, after almost 50 years, revealed the same percentage of nodule carriers as shown at the beginning of the denodulization campaign. However, some Guatemalan investigators believe that denodulization has positively decreased the blinding effects of *Onchocerca volvulus*. Figs. 14 and 15 show denodulization by well trained brigades in an endemic area in Guatemala.

In view of this situation, the Guatemalan Government, through the Onchocerciasis Section of the General Directorate of Public Health Services, predicted the possibility of eradicating the vector black flies; *Simulium ochraceum* (the most dangerous species), *S. metallicum* and *S. callidum*, and preliminary studies are going on. Fig. 8 shows Dr. R. Robles Centro de Investigaciones in Yepo-capa, Dept. of Chimaltenango, which is a laboratory in the endemic area.

The present authors visited some Fincas in endemic foci during the period between Nov., 1973 and Jan., 1974 in order to assess the present situation of endemic onchocerciasis. The results are reported in this paper.

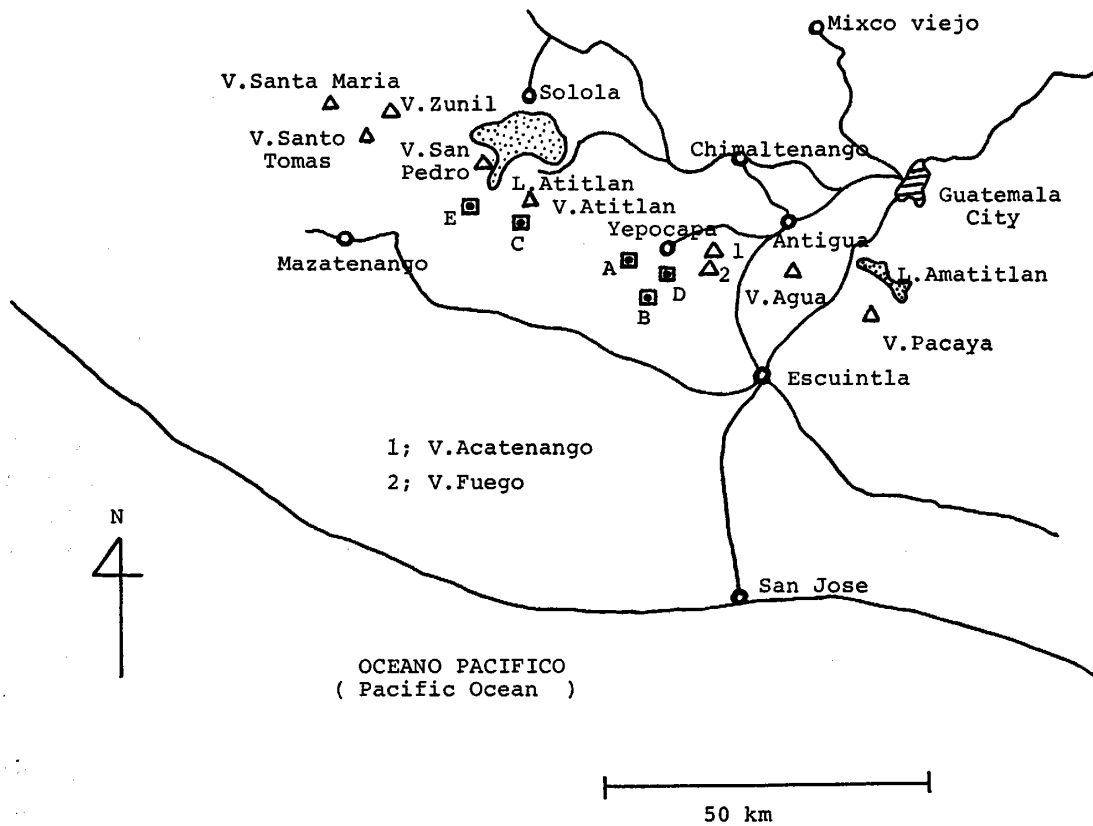


Fig. 1 Map of Southern Guatemala showing the locations of Fincas studied (Dec., 1973–Jan., 1974).

- A; Finca panajabal, B; Finca Rosario Chuarramos  
 C; Finca Monte de oro, D; Finca Nimaya  
 E; Finca Milan

GENERAL VIEWS OF THE REPUBLIC OF GUATEMALA IN RELATION TO ROBLES' DISEASE

The Republic of Guatemala is located at the center of the American Continent forming the northern part of the five Central American Republics. It is situated between 13°42' and 17°49' North and 88°10' and 92°30' West. Its area is approximately 131,800 km<sup>2</sup> and has a little more than 5 millions inhabitants. It is bounded on the north and west by Mexico (Chiapas and Tabasco), on the east by Honduras and the Gulf of Honduras, on the south-east by El Salvador and on the south by the Pacific Ocean.

Characteristics of the country are numerous volcanoes, mountains, lakes, rivers, tropical areas and plains. The Cordilleras of the Sierra Madre run from west to south-east, forming a continuous belt of mountains and volcanoes, dividing the country into two parts; the northern side of the chain with the higher plateaus, and the southern side along the Pacific Ocean. The zone infested with Robles' disease is located on the southern slopes of the volcanoes of Atitlan and San Lucas in the Department of Solola; and Fuego and Acatenango between the Departments of Chimaltenango and Zacatepequez. A relief map of Guatemala is shown in Fig. 6 which will help in the understanding of the situation of the Pacific Cordillera. The endemic zone extends from the Nahualate River in the Department of Suchitepequez in the west, to the Los Escalvos River in the Department of Santa Rosa in the east, and from 1,500 to 5,000 feet above sea level, on the southern side of the Pacific slopes.

The Pacific Coast Land is profusely irrigated by abundant rivers and with abundant rainfall that give birth to many small rivulets and waterfalls, which provide very good breeding places for *Simulium* spp.

The most important cultivation in the zone infested with onchocerciasis is coffee. During harvest time for coffee, many laborers, generally Indians, come from the highlands to the infested zone and many of them acquire the disease.

There are two seasons in Guatemala, the rainy season and the dry season. The first one lasts from May to October, and the second, from November to April. Depending upon the altitude, the climate varies from torrid heat on the coasts, to very cold mountainous regions where snow occasionally falls.

The climate is very important with regard to the distribution of the disease. It is affected by the direction of winds, the slope, the distance from the sea etc.. In the coffee plantations within the endemic zone the temperature generally simulates conditions of the temperate zone.

In Guatemala, there are four endemic areas of Robles' disease: two areas in the Department of Huehuetenango (Northwest of the country); one in the Department of Santa Rosa (the less endemic) and the last one is enclosed in the Departments of Guatemala, Esquintla, Solola, Chimaltenango and Suchitepequez, respectively. The spread of the disease, if it exists, is very slow and the size of endemic foci is almost the same as when it was first discovered.



## MATERIALS AND METHODS

Among the several endemic foci of Robles' disease in Guatemala, the authors surveyed 5 Fincas in Departments of Chimaltenango and Suchitepequez in the following periods.

1. Finca Panajabal: Dept. of Chimaltenango, Dec. 4–Dec. 7, 1973
2. Finca Rosario Chuarramos: Dept. of Chimaltenango, Dec. 11–Dec. 14, 1973
3. Finca Monte de oro: Dept. of Suchitepequez, Dec. 17–Dec. 20, 1973
4. Finca Nimaya: Dept. of Chimaltenango, Jan. 7–Jan. 10, 1974
5. Finca Milan: Dept. of Suchitepequez, Jan. 14–Jan. 17, 1974

The locations of these Fincas are shown in Fig. 1.

1. Skin snips: One snip each was taken from the left scapular region of the person by using a blood lancet and a surgical blade. Skin snips were put into drops of physiological saline on glass slides and incubated for one hour at maximum. Microscopic observations were made under 50× magnification.

2. Onchocercomas: The whole body of approximately 200 inhabitants living in Finca Nimaya was palpated in order to find onchocercal nodules. The onchocercal nodules found were removed surgically by a well trained brigada. The nodules were then preserved in 10% formalin solution for histo-pathological examination.

3. Collection of black flies: In Fincas Monte de oro, Nimaya and Milan, the biting densities of black flies were measured using human bait. Collections were made 6 times a day for 15 minutes every 2 hours with collections starting at 0700 hours (0800 hours in Finca Milan) and ending at 1700 hours (1800 hours in Finca Milan). The collections of black flies were made on 2 portions of the body; the upper part of the body (U) from the waist up, and the lower part of the body (L) from the thigh down to the toes. The collection tubes were made of glass and rubber hose. Throughout the surveys, the same man collected black flies from the upper portion of the body and another one from the lower portion.

4. Mazzotti test: In Finca Milan, 4 microfilaria positives were examined by the Mazzotti test, administering 100 mg Hetrazan (diethylcarbamazine). The skin snips were taken 3 times; at 1000 hours on Jan. 15, immediately before the administration, at 1200 hours, 2 hours later, and at 1000 hours on Jan. 16, 24 hours after the administration. The symptoms and signs which appeared 24 hours after the administration of Hetrazan were recorded.

5. Microfilaria density in the skin. In order to compare the variations in microfilarial densities in the skin at different times of the day with the biting density of black flies in the day time, skin snips were taken from 4 volunteers at 2-hour intervals between 0700 and 1700 hours in Finca Monte de oro. The quantitative skin snip method of Tada *et al.* (1973) was used. The non-teased skin snips were incubated for 12 hours in physiological saline solution in a moist chamber at room temperature. The microfilarial density was expressed as the number of microfilariae in mm<sup>2</sup> skin area.

## RESULTS

## 1) Surveys for microfilaria positives in several Fincas

Table 1 summarizes the results of surveys for microfilarial positives in the inhabitants living in 3 Fincas. In Monte de oro, 53 persons were examined, and 31 microfilarial positives (58.5%) were found. In this Finca, most of the persons examined were aged from 12 to 85 years old. In Nimaya, 123 microfilarial positives (67.6%) were found out of 182 inhabitants; in Milan, 113 positives (46.1%), out of 245 inhabitants. In Tables 2 and 3, sex- and age-distribution of microfilarial positives in Fincas Nimaya and Milan are shown. In Nimaya, the microfilarial rate of males was 76.9% while that of females was 54.1%. Even in Milan, the microfilarial rate of males, 51.9%, was much higher than that of females, 39.3%. Males in Nimaya, aged 20 or more, were highly infected, showing that 83 to 100% of them had microfilariae in comparison with females who had microfilarial rates of 56 to 71%. The differences in microfilarial rates between males and females were more distinct in the younger age groups of the inhabitants in Milan (Table 3). The age distribution curves of the microfilarial rate in Milan people are shown in Fig. 2, which shows significant difference in onchocercal infection between males and females. In male children, the microfilarial positive rate is much higher than in corresponding females

TABLE 1 Microfilarial positives among the inhabitants of 3 Fincas in endemic foci of onchocerciasis in Guatemala (Dec., 1973-Jan., 1974)

Finca	No. examined	No. microfilaria positive	%
Monte de oro	53	31	58.5
Nimaya	182	123	67.6
Milan	245	113	46.1

TABLE 2 The prevalence of positives for *O. volvulus* microfilariae among the inhabitants of Finca Nimaya (Jan. 7-8, 1974)

Age	Male			Female		
	No. examined	No. microfilaria positive	%	No. examined	No. microfilaria positive	%
0-9	9	2	22.2	1	1	100.0
10-19	20	11	55.0	30	12	40.0
20-29	25	22	88.0	16	10	62.5
30-39	23	19	82.6	9	5	55.6
40-49	13	11	84.6	11	7	63.6
50-	18	18	100.0	7	5	71.4
Total	108	83	76.9	74	40	54.1

TABLE 3 The prevalence of positives for *O. volvulus* microfilariae among the inhabitants of Finca Milan (Jan. 14-16, 1974)

Age	Male			Female		
	No. examined	No. microfilaria positive	%	No. examined	No. microfilaria positive	%
0-4	6	1	16.7	5	0	0.0
5-9	16	5	31.3	16	1	6.3
10-14	22	13	59.1	18	3	16.7
15-19	15	5	33.3	12	4	33.3
20-29	30	15	50.0	19	6	31.6
30-39	16	12	75.0	21	13	61.9
40-49	15	11	73.3	10	10	100.0
50-	13	7	53.8	11	7	63.6
Total	133	69	51.9	112	44	39.3

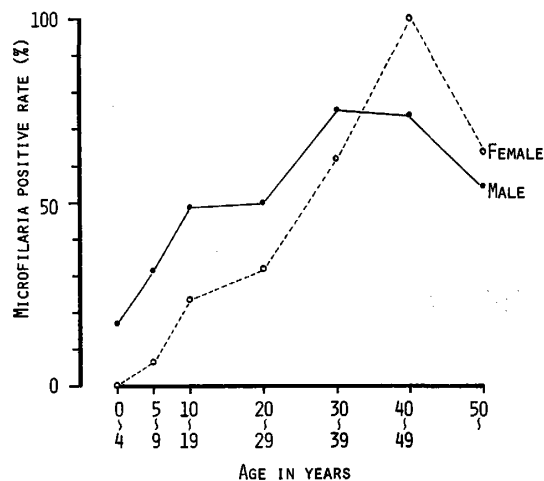


Fig. 2 The age distribution of microfilaria rate arranged by sex in the inhabitants of Finca Milan.

and the microfilarial rates of both sexes increased rapidly with age. However, both males and females, aged 30 years or more, showed equally high microfilarial rates. In Finca Milan, there was a microfilarial positive person (#62, E.H.M. male, 55 years of age) with remarkable dermal lesions as shown in the photograph (Fig. 4). It looked like "Mal morado" which is said to occur frequently in Mexico. The right side of the face was edematous with violet-colored skin lesions and there was congestion and cataracts in the right eye. In Finca Milan, with a population of 375, the authors found 2 completely blind persons, and in Finca Nimaya, with a population of about 300, 3 completely blind cases (Fig. 11). Most of them had a high mfd in their skins.

## 2) Locality of onchocercomas

In Finca Nimaya, the prevalence and the locality of onchocercomas on the body

TABLE 4 Location of onchocercomatas from 31 nodule-positives in Finca Nimaya arranged by age (Jan. 9, 1974)

Age	Iliac region	Scapular region	Costal region	Head				Total
				Parietal	Temporal	Occipital	Frontal	
0-9	1			2				3
10-19	11			1	1		1	14
20-29	2		1	1				4
30-39	1	1		2	1	1		6
40-				3		1*		4
Total	15	1	1	9	2	2	1	31

\* Two nodules were found on the same region.

were studied on approximately 200 inhabitants. A total of 31 persons were found positive out of all those examined. The results are summarized in Table 4. Three nodule-positive cases were found in children below 9 years of age, 14 cases were from those between 10 and 19 years of age, and the rest were found in persons 20 years old or more. The nodules of 15 cases out of 31 were found on the iliac region and 14 cases had their nodules on the head. The nodules were frequently found on the iliac region, especially in young people below 19 years of age. On the other hand, they were found exclusively on the head of people 30 years of age or older. One of the typical onchocercomatas found on the head of a boy in Finca la India is shown in Fig. 5.

3) Biting density of black flies and the concentration of microfilariae in the skin

Four species of black flies, *Simulium (Simulium) ochraceum*, *S. (Simulium) metallicum*, *S. (Lanea) callidum* and *S. (Notolepria) exiguum*, were captured by biting collections in the endemic foci. A total of 1,083 black flies were captured in Finca Monte de oro on Dec. 18 and 19, 1973. Out of 1,083 flies, 1,053 flies were exclusively *S. ochraceum* and 26 were *S. metallicum*. *S. callidum* and *S. exiguum* were very few in this survey. In Fincas Nimaya and Milan, the population density of black flies was relatively low and *S. callidum* was not found (Table 5). The biting density curve of *S. ochraceum* is shown in Fig. 3 with the concentration of *O. volvulus* microfilariae in the skin of 4 volunteers and the room temperature. The room temperature had a peak at 1400 hours and its minimum at 0700 hours. The biting density of *S. ochraceum*, assessed on Dec. 18, had a single peak at 1100 hours while that on Dec. 19 had two peaks at 1100 and 1500 hours, respectively. Although the biting density curves (A) seemed to coincide with the curve of room temperature (C), there was no similar relation between biting density (A) and the concentration of microfilariae in the skin (B) at different times of the day. In this experiment, biting black flies were captured on separate portions of the body; the upper part (U) and the lower part (L). In Finca Monte de oro, a total of 124 *S. ochraceum* were captured at U-portion and 346 at L-portion on Dec. 18: on the next day, a total of 301 were obtained at U-portion and 282 at L-portion. In Finca Milan, a total of 69 *S. ochraceum* were captured at U-portion, and 20, at L-portion, respectively. These facts indicate that almost an equal

TABLE 5 Number of *Simulium* spp. collected at several Fincas in Guatemala with special reference to the portion of body where black flies were captured

Collection site	Portion of body*	<i>Simulium</i> spp.	Time of day (hours)						Total
			07 00	09 00	11 00	13 00	15 00	17 00	
Finca Monte de oro (Dec. 18, 1973)	U	<i>S. ochraceum</i>	0	13	49	41	15	6	124
		<i>S. metallicum</i>	0	0	0	1	0	0	1
	L	<i>S. ochraceum</i>	0	82	102	68	70	24	346
		<i>S. metallicum</i>	0	1	0	4	4	0	9
		<i>S. exiguum</i>	0	0	0	0	1	0	1
		<i>S. callidum</i>	0	0	0	0	1	0	1
Finca Monte de oro (Dec. 19, 1973)	U	<i>S. ochraceum</i>	0	28	127	63	64	19	301
		<i>S. metallicum</i>	0	0	4	0	0	0	4
		<i>S. exiguum</i>	0	0	1	0	0	0	1
	L	<i>S. ochraceum</i>	0	26	68	44	97	47	282
		<i>S. metallicum</i>	0	0	3	1	7	1	12
		<i>S. callidum</i>	0	0	0	0	1	0	1
Finca Nimaya (Jan. 8, 1974)	U	<i>S. ochraceum</i>	1	3	2	1	0	0	7
	L	<i>S. ochraceum</i>	0	0	0	1	0	0	1
		<i>S. metallicum</i>	0	0	1	0	0	0	1
		<i>S. exiguum</i>	0	0	1	0	0	0	1
			08 00	10 00	12 00	14 00	16 00	18 00	
Finca Milan (Jan. 16, 1974)	U	<i>S. ochraceum</i>	15	19	14	12	9	0	69
		<i>S. metallicum</i>	0	0	1	0	1	0	2
		<i>S. exiguum</i>	0	0	0	0	1	0	1
	L	<i>S. ochraceum</i>	1	2	4	11	1	1	20
		<i>S. metallicum</i>	1	1	2	1	4	0	9
		<i>S. exiguum</i>	2	1	0	1	1	0	5

\* U, the upper portion of body from the waist to up; L, the lower portion of body from the thigh down to the toes.

\*\* *Simulium* collection was made for 15 minutes at every collection time.

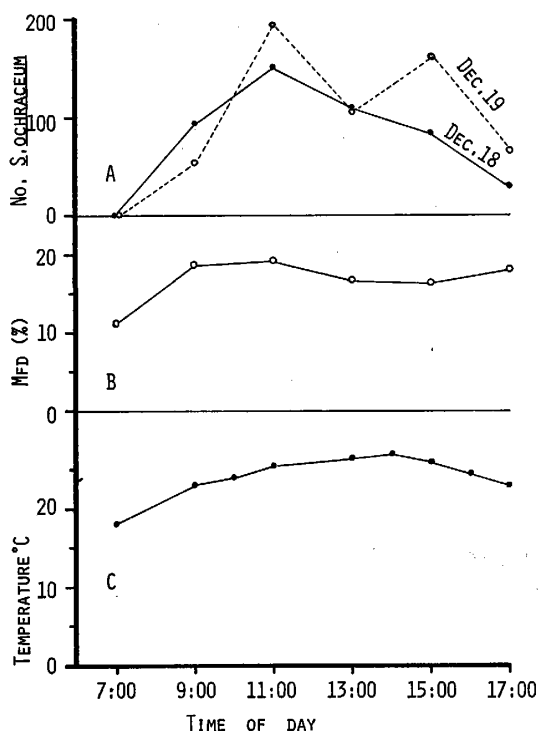


Fig. 3 (A) Biting density of *S. ochraceum* (fly/15 minutes/boy) at different time of days, Dec. 18 and 19, 1973, at Finca Monte de oro, (B) average microfilaria density (%) of *O. volvulus* microfilariae in the skins of 4 microfilaria positives, and (C) room temperature.

number of *S. ochraceum* were collected from both the upper and the lower portions of the body.

#### 4) Mazzotti test on 4 microfilarial positives

Two hours after the oral administration of 100 mg Hetrazan, cases #50 and 52 complained of itching over the upper half of their bodies and their palpebral and bulbar conjunctiva showed strong congestion. Twenty four hours after administration, the signs and symptoms appearing in the 4 volunteers were as follows:

#50 (F.P., 23 yrs. old, male): Demarcated edematous skin with tenderness was seen symmetrically in the back, scapular and shoulder regions. The skin was reddish

TABLE 6 Microfilaria density of 4 volunteers during the course of the Mazzotti test (Jan. 15-16, 1974, Finca Milan)

Examinee	Age	Sex	MFD			Mazzotti test
			Before administration	2 hours post administration	24 hours post administration	
# 50	23	Male	1.2	3.5	3.8	+++
# 51	20	Male	0.7	2.0	0.7	-
# 52	28	Male	5.0	1.7	2.4	+++
# 53	38	Male	0.9	1.9	7.2	+++

and provided with scattered miliary tubercles as shown in Fig. 13. The patient complained of hyperesthesia of the skin and general fatigue.

#51 (C.S., 20 yrs. old, male); Slight itching of some body regions was the only symptom found in this case. No congestion in the conjunctiva and no pathological changes of the skin were demonstrated. On the contrary, the skin was pale all over the body and the palpebral conjunctiva was also anaemic.

#52 (A.M., 28 yrs. old, male); Remarkable congestion was seen in the bulbar and palpebral conjunctiva. Edema of the skin was seen in the left buttock, inguinal and femoral regions. There was neither swelling of inguinal lymph nodes nor femoral ones. The patient complained of hyperesthesia when skin was touched and of shaking chills with fatigue.

#53 (J.P., 38 yrs. old, male); The skin of the left subaxillary and bilateral supra-thoracal regions was reddish and thick with edema. No swollen axillary lymph nodes were palpable. The patient had fatigue and shaking chillness (Fig. 12). Summarizing the reactions observed, cases #50, 52 and 53 were considered as strongly positive with the Mazzotti reaction, while case #51 was considered negative because of the lack of local reactions except weak itching. Table 6 shows the changes in the mfd after the administration of Hetrazan. There was no reduction in the mfd in all the cases studied.

#### DISCUSSION

Figueroa and Garcia (1971) found 115 (73.2%) microfilarial positives out of 157 inhabitants examined in Nimaya and 122 (61.6%) positives out of 198 in Milan. These Fincas showed the following microfilarial rates in this survey; 67.6% in Nimaya and 46.1% in Milan. The microfilarial rate of the latter Finca seems to have been reduced between 1971 and 1974. However, no *Simulium* control and no mass treatment, except denodulization, were carried out during this period. It is, for this reason, difficult to interpret the reduction in the microfilarial positive rate from the viewpoint of the reduction of filarial transmission. The authors examined only one skin snip from each person. This method may often result in negatives when cases with a low mfd were examined. Further, the difference in the number of examinees, the percentage of females among them, the incubation conditions and other technical differences should be taken into consideration in order to explain the apparent reduction in the microfilarial positive rates.

In Finca Milan, the microfilarial positive rates in males were much higher than in corresponding females under 39 years of age. Thereafter, that of the females was rather higher than males. This fact indicates that younger males are more frequently exposed to infected black flies while working as laborers in the farm fields in comparison with females. A similar tendency was also seen in the inhabitants of Nimaya. García Sánchez and Chávez Núñez (1962) have emphasized the risk that in some endemic foci in Mexico, onchocerciasis might spread to non-infected areas through the migration of laborers. In Guatemala, the present authors would like to express the same opinion.

Bernhard (1965) summarized 25 years of onchocerciasis control in Guatemala

between 1935 and 1964. Despite the great efforts of systematic denodulization all over the endemic foci in these years, the proportion of nodule carriers continued to be relatively high and constant. In our survey in Finca Nimaya, 31 cases (about 15%) with nodules were found out of approximately 200 subjects. Among those examined, there were many who were repeatedly denodulized in previous years. No attenuation of the filarial transmission was confirmed by this finding. As shown in Table 4, 17 nodules out of 31 were found in the body, especially in the iliac region. Bernhard (1965) has also emphasized that the occurrence of nodules on the body trunk was unexpectedly high by demonstrating nodule rate as follows; 40.00% in 1940, 38.85% in 1950, 34.25% in 1957 and 37.04% in 1964. Therefore, it should not be concluded that the head is the only preferable site for adult *Onchocerca volvulus* in Guatemalan cases.

Dalmat (1955) studied the relation of time of the day to the biting habits of *S. ochraceum*, *S. metallicum* and *S. callidum* and concluded that the most active feeding period was from 8 a.m. to 10 a.m. *S. metallicum* started feeding in the morning at about the same time as *S. ochraceum*, preferring the hours of 8–10 a.m., but it continued to feed in good numbers until 5:30 p.m.. On the other hand, *S. callidum* differed from both *S. ochraceum* and *S. metallicum* in that it preferred to bite from dawn to about 9 a.m. and again from 3 or 4 p.m. until twilight. In the present study, the great majority of the captured flies were *S. ochraceum* which bit human bait most actively in the period from 9 a.m. to 3 p.m. of the day. This result coincides with that reported by Dalmat. Furthermore, Dalmat reported that *S. ochraceum* showed definite preferences for the upper regions of the body when a person was fully exposed to the bites. On the contrary, in the present study, it was roughly considered that *S. ochraceum* bite both the upper and the lower parts of the body equally.

The Mazzotti test had been frequently used as a diagnostic aid in field studies, especially in Central America. With regard to the validity of this test, there are many investigators who consider this test to be useful in diagnosis, whereas there are some who oppose to this consideration. For example, Oomen (1969) thought that this test was of little value in Ethiopian patients because he had already found many false-negatives even in persons with positive skin snips (No reaction against diethyl-carbamazine was found in 22% of the patients examined). In the present study, 3 out of 4 volunteers administered small amounts of Hetrazan showed general and local reactions which were nuisance to those subjects. However, one microfilarial positive person (#51 in Table 6) did not show any striking reactions nor an increase in the preexisting itching. The presence of this kind of false negative reaction in Mazzotti test should be taken into consideration for diagnostic purposes.

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### グアテマラ共和国におけるロブレス病（アメリカ型 オンコセルカ症）の疫学的研究

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グアテマラにおけるオンコセルカ症浸淫の現状を知る目的で1973年11月から1974年1月にかけていくつかの流行地にあるフィンカ（農場）の住民を調査した。仔虫保有率はモンテ・デ・オロ農場住民の場合58.5%，ニマヤでは67.6%，ミランで46.1%であった。仔虫保有者は男児の場合、女児よりはるかに高く、以後保有率は両性とも年齢と共に急増していた。この差は男性では小さい時からコーヒー収獲の労働者として野外で長く感染ブユにさらされているのが主因と思われる。ニマヤ農場ではオンコセルカ腫瘍保有者の調査を実施した。約200名の被検者のうち31名が腫瘍を保有していたが、腫瘍はその半数が頭部に見出され残り半数が腰部から見出された。この事実は中米では腫瘍が頭部に集中するという一般的な見解に反していた。3個所で人をオトリに伝搬ブユの biting collection を実施したが捕獲されたブユの殆んどは *S. ochraceum* で残りの少数が *S. metallicum*, *S. callidum* 及び *S. exiguum* であった。ブユの biting 密度は1日のうちで9時から15時までが最も高く、その密度分布はほぼ1峰性と考えられた。また4人の感染者皮膚内の時間別仔虫密度とブユの biting 密度の間に関連は見られ

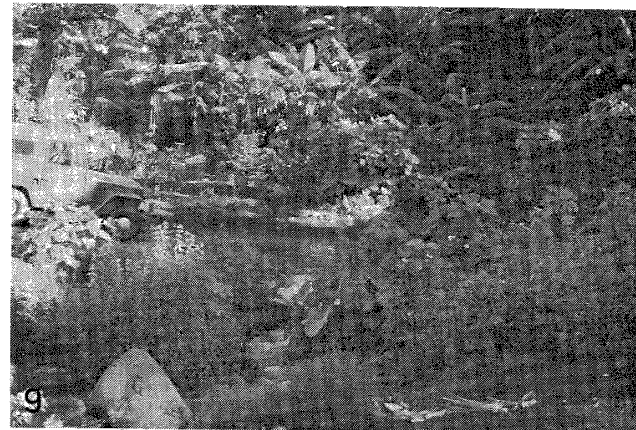
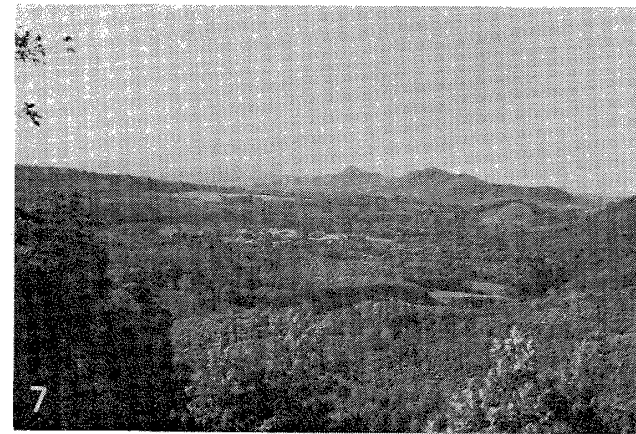
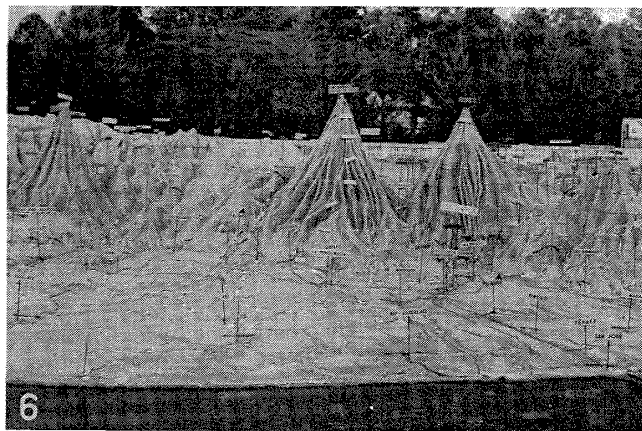
1 金沢医科大学医動物学教室 2 グアテマラ共和国厚生省オンコセルカ部 3 鹿児島大学医学部医動物学教室

なかった。更にオトリの身体部分で分けると下半身からも上半身と略同数のブユが採取された。4人の  
仔虫保有者についてマソッティ試験を実施し3人につよい陽性反応を見たのでその所見を記載した。  
今回の簡単なサーベイによってもグアテマラ共和国の流行地においては、オンコセルカ伝搬が従来どお  
りおとろえることなく継続していることが確かめられ、改めて本症対策の重要性が痛感された。



Fig. 4 Dermal lesion found in the right half of the face of a 55-year man (#62, E.H.M.) (Jan., 1974).

Fig. 5 An onchocercomata found on the head of a boy in Finca la India (Jan., 1974).



- Fig. 6 Relief map of the Pacific Cordillera of Guatemala. Yepo-capa is located on the left slope of Volcan Fuego (center) (Jan., 1974).
- Fig. 7 View of Yepo-capa, a small town located in the endemic focus in Dept. of Chimaltenango, Guatemala (Dec., 1973).
- Fig. 8 View of Dr. R. Robles Centro de Investigaciones which is built in Yepo-capa (Dec., 1973).
- Fig. 9 A stream flowing close to Yepo-capa, where the inhabitants wash their clothes and the vector black flies breed (Dec., 1973).



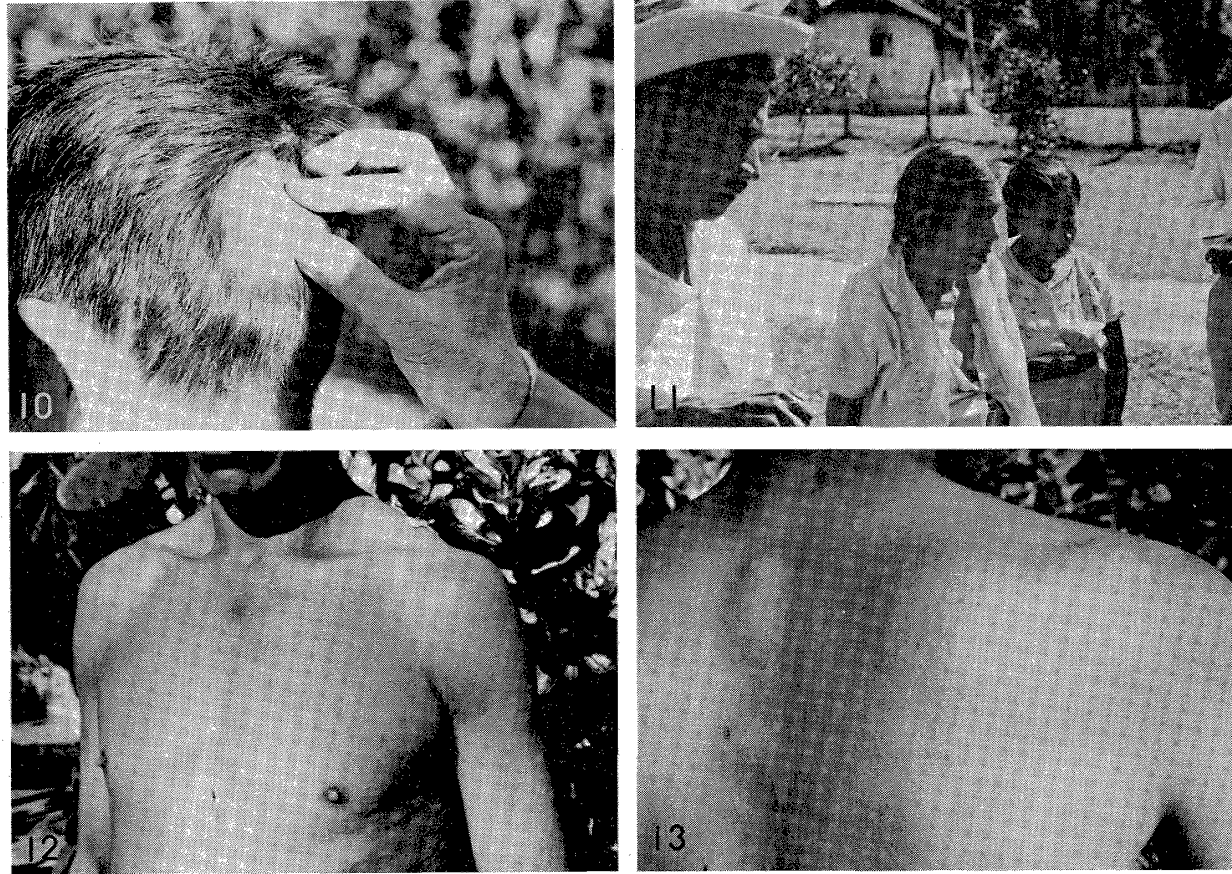
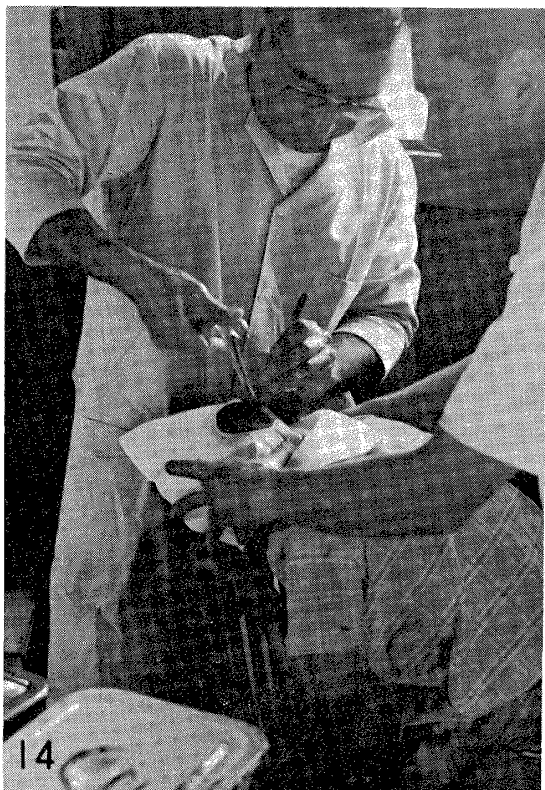


Fig. 10 An onchocercomata on the head of a boy in Finca Nimaya, Dept. of Chimaltenango, Guatemala (Jan., 1974).  
 Fig. 11 Three blind persons found in Finca Nimaya (Jan., 1974).  
 Figs. 12 and 13 Skin lesions shown in 2 microfilaria positive persons 24 hours after the administration of 100 mg Hetrazan (Mazzotti test) in Finca Milan (Jan., 1974).



Figs. 14 and 15 Denodulization by a brigada in Finca Panajabal, Dept. of Chimaltenango, Guatemala (Jan., 1970).

## THE RESISTANT LEVEL OF THE HOUSEFLIES TO SEVERAL SYNTHETIC INSECTICIDES IN INDONESIA<sup>1</sup>

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**Abstract:** The resistant level of the houseflies to the several kinds of insecticides, pyrethrins, allethrin, Sumithion (fenitrothion), diazinon, DDVP, Baytex,  $\gamma$ -BHC and DDT, were examined on the sixteen strains collected in Indonesia. It was found that many housefly colonies in Indonesia showed higher susceptibility to these insecticides than the Takatsuki strain, especially the flies collected in Ambon, Celebes, Flores, Bali, Timor and Lombok Islands were found to be high susceptible for 9 insecticides. A few samples of flies from Indonesia showed tolerant to Sumithion, especially high LD<sub>50</sub> values were obtained in the flies from 3 places of Jakarta city (0.615, 0.560 and 0.407  $\mu$ g, respectively) and from Kabanjahe, Sumatra (0.435  $\mu$ g). These LD<sub>50</sub> values were much higher than the value of Takatsuki strain (0.088  $\mu$ g).

### INTRODUCTION

There are many reports of the studies on the insecticide resistance of houseflies in Japan. Hayashi (1973) published the reports of the studies performed in the past 10 years in 1973. Hayashi and Hatsukade (1974) reported on the houseflies in Okinawa and Taiwan. However, there is no report on the houseflies in Indonesia.

During the period from the beginning of November to the end of December in 1973, the authors had opportunity to study on the flies in Indonesia. The houseflies were collected at 16 areas in Indonesia and sent alive to Tokyo, and then the resistance of the flies to several insecticides was evaluated. The results of the study are presented in this paper.

### MATERIAL AND METHODS

**Houseflies:** The houseflies used in this study were collected at 16 areas in Indonesia. Those were kept in plastic cups, 5 cm in diameter and 10 cm in heights, with breeding media. The eggs oviposited on the media were transferred to new breeding cups and then bred to the pupae. The pupae were sent to the laboratory in Tokyo by air cargo. In the laboratory, the flies were reared and raised, and then

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subjected for study.

The areas where houseflies were collected and the date are as follows: JAVA: Bogor, 10 Nov. (1); Jakarta, fish market, 11 Nov. (2); Jakarta, central part of city, 11 Nov. (3); Jakarta, Kebayoran Baru, 11 Nov. (4); Cirebon, Sankauhurip, 22 Nov. (5); SUMATRA: Medan, central market, 20 Nov. (6); Berastagi, market, 21 Nov. (7); Kabanjahe, market, 23 Nov. (8); CELEBES: Ujung Pandang, market, 27 Nov. (9); Ujung Pandang, a hotel in downtown, 28 Nov. (10); Manado, market, 2 Dec. (12); AMBON: Ambon city, market, 1 Dec. (11); FLORES: Maumere, market, 19 Dec. (13); BALI: Denpasar, market, 14 Dec. (14); TIMOR: Kupang, market, 15 Dec. (15); LOMBOK: Mataram, market, 21 Dec. (16).

Takatsuki strain was used as a standard strain for comparing the resistant values with Indonesian strains at the same time.

Insecticides: The insecticides used in this study were as follows: pyrethrins, allethrin, Sumithion (purity=98.67%), malathion (95.5%), diazinon (99.6%), DDVP (97.6%), Baytex (99.2%),  $\gamma$ -BHC (99.0%) and Technical-DDT.

Methods: Each insecticide was diluted with acetone to the required concentration. The level of resistance was determined by a topical application method. The female flies (body weight: 21–23 mg) were anesthetized by carbon dioxide, and 0.5  $\mu$ l of the diluted insecticides was applied to the scutum of flies, respectively. The treated flies were then transferred to the clean vessels with cotton balls soaked with sugar water for 24 hour mortality count under a constant temperature of 25 C. Thirty females were used for each concentration and same tests were conducted 3 times. As a control, acetone was treated in the same way.

## RESULTS AND DISCUSSION

The results of the test on the Indonesian houseflies were shown in Table 1. From the results, it was found that many housefly strains in Indonesia were highly susceptible to the insecticides. The results of the test to each insecticide are as follows:

Allethrin: The strain No. 11 (0.07  $\mu$ g) showed highest susceptibility to the allethrin and No. 8 (0.538  $\mu$ g) showed lowest. LD<sub>50</sub> value of No. 8 was 8 times of No. 11. Therefore, if No. 11 is assumed as the standard strain to the allethrin, No. 8 is the tolerant strain. LD<sub>50</sub> values of 4 strains, No. 5, 8, 9 and 10, were higher than that of Takatsuki strain, however, these are not higher in comparison with those of tolerant strains in Japan. Their LD<sub>50</sub> values are 3.970  $\mu$ g (Kohch) (Hayashi and Matsuzaki, 1973), 1.481  $\mu$ g (Misaki) (Hayashi et al., 1973), 1.885  $\mu$ g (Sapporo) (Hayashi and Hasegawa, 1973) and so on. Those values are much higher than that of highest Indonesian strain (No. 8), 7.37 $\times$ , 2.75 $\times$  and 3.49 $\times$ , respectively.

Pyrethrins: LD<sub>50</sub> values to the pyrethrins were from 0.044  $\mu$ g (No. 16) to 0.423  $\mu$ g (No. 12). The value of No. 12 was about 9.6 times of No. 16, and about the same value as Takatsuki strain (0.387  $\mu$ g). Comparing the value of No. 12 with Japanese tolerant strains, Nangoku (2.147  $\mu$ g) (Hayashi and Matsuzaki, 1973), Makomanai (1.298  $\mu$ g) (Hayashi and Hasegawa, 1973) and Hashimoto (0.716  $\mu$ g) (Hayashi et al., 1973), it seems that No. 12 is not a tolerant strain.



TABLE 1 LD<sub>50</sub> values for 9 insecticides of the adult female houseflies in Indonesia ( $\mu\text{g/insect}$ )

Colony name No. 1.	Collection site Java (Bogor)	Allethrin 0.423	Pyrethrins 0.110	Sumithion 0.224	Diazinon 0.171	Malathion 0.710	DDVP 0.060	Baytex 0.133	$\gamma$ -BHC 0.312	DDT 1.397
No. 2.	Java (Jakarta)	0.307	0.146	0.407	0.330	0.787	0.143	0.216	0.515	1.062
No. 3.	Java (Jakarta)	0.285	0.182	0.560	0.259	0.220	0.126	0.151	0.327	1.542
No. 4.	Java (Jakarta)	0.198	0.103	0.615	0.273	1.292	0.094	0.185	0.358	0.603
No. 5.	Java (Cirebon)	0.497	0.213	0.146	0.175	0.467	0.033	0.110	1.611	3.752
No. 6.	Sumatra (Medan)	0.154	0.188	0.072	0.126	0.318	0.021	0.043	0.330	1.449
No. 7.	Sumatra (Berastagi)	0.369	0.150	0.178	0.204	0.393	0.039	0.089	0.509	4.249
No. 8.	Sumatra (Kabanjahe)	0.543	0.191	0.435	0.309	0.698	0.066	0.174	0.906	2.932
No. 9.	Celebes (Ujung Pandang)	0.534	0.188	0.069	0.075	1.854	0.032	0.051	0.394	0.703
No. 10.	Celebes (Ujung Pandang)	0.487	0.269	0.246	0.235	0.582	0.076	0.128	1.404	7.251
No. 11.	Ambon (Ambon)	0.070	0.280	0.054	0.089	0.217	0.011	0.034	0.153	2.683
No. 12.	Celebes (Manado)	0.142	0.423	0.076	0.171	0.249	0.011	0.025	0.033	1.567
No. 13.	Flores (Maumere)	0.160	0.071	0.024	0.019	0.269	0.007	0.018	0.006	0.433
No. 14.	Bali (Denpasar)	0.247	0.095	0.058	0.128	0.222	0.029	0.041	0.116	0.406
No. 15.	Timor (Kupang)	0.326	0.153	0.013	0.015	0.097	0.029	0.016	0.179	0.830
No. 16.	Lombok (Mataram)	0.087	0.044	0.049	0.084	0.097	0.013	0.027	0.105	0.908
Takatsuki		0.481	0.387	0.088	0.293	0.454	0.076	0.135	4.547	46.900

Considering the results of the test to 2 pyrethroids, almost all Indonesian strains are susceptible rather than tolerant to the pyrethroids.

**Sumithion:** LD<sub>50</sub> values to the Sumithion were between 0.013  $\mu\text{g}$  (No. 15) and 0.615  $\mu\text{g}$  (No. 4). The value of No. 4 was about 47.3 times of the No. 15. LD<sub>50</sub> values of eight strains were higher than that of the Takatsuki (0.088  $\mu\text{g}$ ); No. 1 (0.224  $\mu\text{g}$ ), No. 2 (0.407  $\mu\text{g}$ ), No. 3 (0.560  $\mu\text{g}$ ), No. 4 (0.615  $\mu\text{g}$ ), No. 5 (0.146  $\mu\text{g}$ ), No. 7 (0.178  $\mu\text{g}$ ), No. 8 (0.435  $\mu\text{g}$ ) and No. 10 (0.246  $\mu\text{g}$ ), and those values were about 2.5, 4.6, 5.7, 6.9, 1.6, 2.0, 4.9 and 2.7 times of Takatsuki strain, respectively. However, those values were much lower comparing with tolerant strains in Japan, Misaki (92.535  $\mu\text{g}$ ) (Hayashi *et al.*, 1973) and Nangoku (1.624  $\mu\text{g}$ ) (Hayashi and Matsuzaki, 1973), whose values were 1,051 and 18.45 times of Takatsuki, respectively.

**Malathion:** LD<sub>50</sub> values to malathion were between 0.097  $\mu\text{g}$  (No. 6) and 1.854  $\mu\text{g}$  (No. 9), and the value of No. 9 was 19 times of No. 6. The strains which showed same or higher LD<sub>50</sub> values than Takatsuki strain (0.454  $\mu\text{g}$ ) were No. 1 (0.710  $\mu\text{g}$ ), No. 2 (0.787  $\mu\text{g}$ ), No. 4 (1.292  $\mu\text{g}$ ), No. 8 (0.698  $\mu\text{g}$ ), No. 9 (1.854  $\mu\text{g}$ ) and No. 10 (0.582  $\mu\text{g}$ ). Among them No. 4 (2.8 $\times$ ) and No. 9 (4.0 $\times$ ) strains showed comparatively higher values, but their values were lower than those of Taipei (296.00  $\mu\text{g}$ ) (Hayashi and Hatsukade, 1974) and Shuri (240.04  $\mu\text{g}$ ) (Hayashi and Hatsukade, 1974).

**Diazinon:** To the diazinon, the LD<sub>50</sub> values were between 0.015  $\mu\text{g}$  (No. 15) and 0.330  $\mu\text{g}$  (No. 2), and the value of No. 2 was 22 times of No. 15. The LD<sub>50</sub> values of No. 2 and No. 8 (0.309  $\mu\text{g}$ ) were higher than that of Takatsuki (0.293  $\mu\text{g}$ ), but lower than tolerant strain, Misaki (26.089  $\mu\text{g}$ ) (Hayashi *et al.*, 1973), of Japan. This value was about 79 times of No. 2 strain.

**DDVP:** The LD<sub>50</sub> values to the DDVP were between 0.007  $\mu\text{g}$  (No. 13) and 0.143  $\mu\text{g}$  (No. 2), and the value of No. 2 was 20.4 times of No. 13. The values of No. 2 (0.143  $\mu\text{g}$ ), No. 3 (0.126  $\mu\text{g}$ ), No. 4 (0.094  $\mu\text{g}$ ) and No. 10 (0.076  $\mu\text{g}$ ) were the same or higher than that of Takatsuki (0.076  $\mu\text{g}$ ), however, those values were lower than some tolerant strains in Japan, Nakayama (1.06  $\mu\text{g}$ ) (Hayashi and Hasegawa, 1974) and Nangoku (0.483  $\mu\text{g}$ ) (Hayashi and Matsuzaki, 1973). Those values were about 7.4 and 3.3 times of No. 2, respectively.

**Baytex:** The LD<sub>50</sub> values to the Baytex were between 0.016  $\mu\text{g}$  (No. 15) and 0.216  $\mu\text{g}$  (No. 2), and the value of No. 2 was 13.5 times of No. 15. Four strains showed higher values than Takatsuki (0.135  $\mu\text{g}$ ). Those were No. 2, No. 3 (0.151  $\mu\text{g}$ ), No. 4 (0.185  $\mu\text{g}$ ) and No. 8 (0.174  $\mu\text{g}$ ) and 1.6, 1.1, 1.3 and 1.2 times of Takatsuki, respectively. Those values were lower than those of resistant strains, Hahajima (0.866  $\mu\text{g}$  and 6.5 $\times$ ) (Hayashi and Kano, 1974), Hamura (0.483  $\mu\text{g}$  and 3.5 $\times$ ) (Hayashi and Kano, 1974), Taipei (0.390  $\mu\text{g}$  and 2.8 $\times$ ) (Hayashi and Hatsukade, 1974) and Shuri (0.323  $\mu\text{g}$  and 2.3 $\times$ ) (Hayashi and Hatsukade, 1974). It is interesting, however that the values were higher than that of Yumenoshima strain (0.10  $\mu\text{g}$ ) (Yasutomi, 1966) which is known as a resistant strain to the organic phosphorous insecticides.

The Indonesian houseflies were rather susceptible to the organic phosphorous insecticides, however, it is developing a tendency to gain resistance or tolerance to

the Sumithion and malathion. That reason can not be made clear in the present study, but the strains from the Jakarta city showed higher resistant values than the other strains. It is supposed that this is influenced by the use of insecticides.

$\gamma$ -BHC: The LD<sub>50</sub> values to  $\gamma$ -BHC were from 0.006  $\mu$ g (No. 13) to 1.611  $\mu$ g (No. 15). The value of No. 15 was about 268.5 times of No. 13. The value of No. 13 was lowest value in the present study.

DDT: The LD<sub>50</sub> values to DDT were from 0.406  $\mu$ g (No. 14) to 4.249  $\mu$ g (No. 7), and the value of No. 7 was 10.4 times of No. 14.

The resistant levels of the Indonesian houseflies to the chlorinated hydrocarbon insecticides were significantly lower than those of tolerant strains. Comparing with the susceptible strain, Takatsuki (4.547  $\mu$ g), the LD<sub>50</sub> values to the  $\gamma$ -BHC were about one third in No. 5 and 1/757 in No. 13. The same result was observed in cases of DDT. The LD<sub>50</sub> values to the DDT were about 1/115 that of Takatsuki strain in No. 13 and 1/11 in No. 5.

It was found that many housefly colonies in Indonesia tested in this study showed higher susceptibility to all insecticides tested than the Takatsuki strain, especially the flies collected in small towns which have small population. However, a few colonies from Java, No. 2, 3 and 4, and Sumatra, No. 8, showed tolerance to the Sumithion.

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### インドネシア産イエバエの数種殺虫剤に対する感受性について<sup>1</sup>

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インドネシア国内8島16カ所でイエバエを採集飼育し、生きたまま日本へ輸送し、これら16の株の殺虫剤感受性を調べた。用いた殺虫剤は9種類で、ピレトリン、アレスリン、スミチオン(フェニトロチオン)、マラサイオン、ダイアジノン、DDVP、バйтеックス、 $\gamma$ -BHCおよびDDTである。その結果、インドネシア産イエバエは日本産イエバエ(高槻系)に比較して、これらの殺虫剤に対し、高い感受性を示した。とくにアンボン、セレベス、フローレス、バリ、チモール、ロンボクの諸島の系統が各種の殺虫剤に対して高い感受性を示した。しかし少数のものは、スミチオン耐性を持っており、これらは、ジャカルタの3カ所およびスマトラの1カ所の株にみられた。これらは日本の高槻系よりも大なるLD<sub>50</sub>値を示した。なお $\gamma$ -BHC、DDTなど塩素系殺虫剤に対しては日本産イエバエより著しく高い感受性がみられた。

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## A CASE OF HUGE PENILE AND SCROTAL ELEPHANTIASIS

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**Abstract:** From 1955 through 1970 the transition of filarial symptomatic patients in a town of Bonotsu, located on the southernmost part of Satsuma peninsular, Kagoshima prefecture, had been investigated. The investigations showed that number of hydrocele and chyluria patients had a tendency of decrease, though new such cases occurred at times. New cases of elephantiasis were not found as far as our investigations were concerned and the number of the disease reduced by half in ten years. A case of huge elephantiasis of the scrotum and the penis we saw lately is described. The patient is a male, 44 years old, who lives in Tokunoshima, Oshima-gun, Kagoshima prefecture. The first filarial fever attack was noticed when he was 14 years old and since then the attack would usually occur after labor once or twice a month. The patient's penis had started to increase in size gradually when he was 17 years old and at 34 it grew as low as his knee joints. Afterwards the patient's penis has grown as long as his legs without being accompanied by episodes of fever attacks or chyluria. The patient's waist is 66.3 cm (circumference) and the largest part of the scrotum 76.8 cm (circumference), which shows the scrotum is larger than the patient's waist by more than 10.0 cm. The length of the penis is 58.0 cm; the smallest part, coronary sulcus, 43.5 cm. A circumference of the glans penis is 50.5 cm. Total weight of the penis and the scrotum amounts to about 18.5 kg, which forms one-third the body weight, in contrast with the patient's height (142.0 cm) and body weight (52.6 kg). We report scrotal elephantiasis which is accompanied by penile elephantiasis, that is thought to be very rare.

## INTRODUCTION

Filariasis presents such variegated symptoms as filarial fever attack, lymphadenovary, chyluria, hydrocele and elephantiasis, etc..

Among those abnormal symptoms elephantiasis has drawn attention of the public from old times due to its unusual shape. In Japan The Kumagaishi — a historical book written about Kuma (Hitoyoshi, Kumamoto prefecture) district — describes hydrocele that was seen as far back as the days of the 24th, Haruhiro (1512-1555), of the Sagara family and a famous painter, Hokusai Katsushika (1760-1849) painted an ukiyoe — a picture of everyday life in old Japan — of scrotal elephantiasis, which facts may indicate that in Japan filariasis has been prevalent from old times.

Typical elephantiasis cases, however, have rarely been seen recently. Table 1

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shows results of follow-up studies on filarial symptomatic patients made by the authors for 16 years (1954–1970) at Kiyohara which has about 1,000 population, Bonotsu-cho located on the southernmost part of Satsuma peninsular, Kagoshima prefecture. Bancroftian microfilaria positive rate among inhabitants of Kiyohara was 8.6% in 1962.

There had been eleven elephantiasis patients in 1954 and thereafter until 1965 four of them died (cause unknown) and one moved out, which made six patients were still living on investigation in 1970. Any newly occurred elephantiasis case was not found during 1954–1970. In 1954 there had been twenty-seven hydrocele patients and thereafter nine of them died and one moved out till 1965 — decrease of ten hydrocele patients —, though three new cases occurred during the period. Later in 1970 another new case of hydrocele was found.

Fourteen chyluria patients had been confirmed by the authors in 1954 and on the occasion of investigation made in 1965 it was found that three of them died, one moved out and seven new cases occurred. In addition, two new cases of chyluria were also found in 1970.

As shown above, new chyluria cases have been found even recently, though, on the contrary, elephantiasis and hydrocele patients have become relatively rare in occurrence these days.

A case of huge penile and scrotal elephantiasis we have found lately is presented in this paper.

#### CASE

- 1) The patient (K.H.): 44 years old, male.
- 2) Present Address: Tokunoshima (Toku island), Ohshima-gun, Kagoshima prefecture.
- 3) Chief Complaints: Scrotal and penile enlargement, swelling of left lower extremity.
- 4) Family History: Non-contributory.

**Past History:** The patient has been of inborn mental deficiency to the extent that his mental power could not be expressed by the I.Q. (intelligent quotient), which forced him to give up school after first grader. A diagnosis of hypertension was made on the patient about two months ago.

**Present Illness:** He had lived in a hut in mountaneous terrain until thirteen years old and had never used a mosquito net notwithstanding lots of mosquitoes in and around the area. After thirteen year old he has lived in a sparsely-populated village in the level land. A filarial fever attack (high fever, ague and shiver) started to develop once or twice a month when he was fourteen years old, which continued until thirty. The fever attack usually occurred after labor such as mowing. His penis had begun to increase in size gradually at the age of seventeen and until thirty-four it grew as low as his knee joint. At the age of thirty-four microfilariae were detected in the peripheral blood by mass blood survey performed by the health center. Diethylcarbamazine administration to him was instituted, which was suspended halfway later due to an unknown cause. Blood examination for microfilaria detection

made on him at the age of forty showed negative. An episode of chyluria has never been seen with him so far. No any episode of a fever attack has been noted recently, either. His penis at present has grown as long as his lower extremity. The patient has never complained of dysuria except 'oozing out of urine from the tip of the penis' when he feels urination terminates.

**System Review:** Physique moderately developed. Nourishment fair. Countenance is idiotic with a relatively smaller head in size. Puls rate is 74 per minute with regular rythm and good tension. Blood pressure 152/70 mmHg. Neither anaemia nor icterus are noted. Physical findings of the lungs, the cardiac and the abdomen are not remarkable. There is no significant lymphadenopathy in the cervical and the axillary regions. A soybean-sized lymph node is palpable in the both inguinal regions. There is overall enlargement of the left lower extremity but neither redness nor keratosis of the skin are noted. The huge penis and scrotum are seen.

Findings of the scrotum and the penis (Fig. 1 and photographs):

Measurements are as follows: Total weight of both the penis and the scrotum

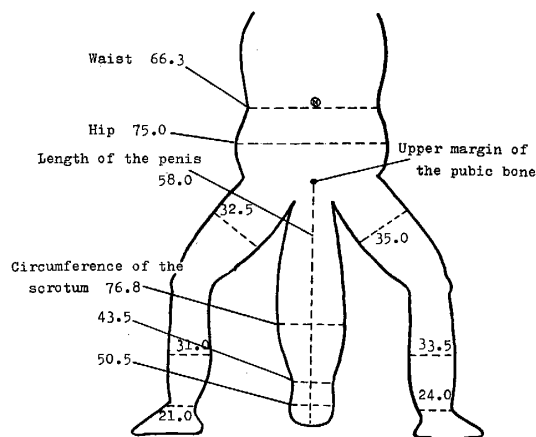


Fig. 1 Measurements (cm).

Body length 142.0 cm; Body weight 52.6 kg; Penis+Scrotum 18.5 kg

TABLE 1 Transition of symptomatic patients at Kiyohara

Diseases	Transition of No. of symptomatic patients in 11 years					as of 1965	newly-occurred cases in 1970
	1954	died patients	moved out patients	total	newly-occurred patients		
Elephantiasis	11	4	1	5	0	6	0
Hydrocele	27	9	1	10	3	20	1
Chyluria	14	3	1	4	7	17	2
<b>Total</b>	<b>52</b>	<b>16</b>	<b>3</b>	<b>19</b>	<b>10</b>	<b>43</b>	<b>3</b>

amounts to about 18.5 kg, which forms one-third the body weight, in contrast with his height (142.0 cm) and body weight (52.6 kg). The length of the penis is 58.0 cm. The largest part of the scrotum measures 76.8 cm in circumference which is larger than the waist (66.3 cm) by more than 10.0 cm. The smallest part of the penis, coronary sulcus, is 43.5 cm and glans penis 50.5 cm. A 'cleft' is visualized on the tip of the penis, out of which urine is seen oozed, though an external meatus urinarius cannot be confirmed. The surface of the penis is rigid and uneven with abundant warty and nodular protuberances and furrows on it. Scattered brown or black pigmentary deposits are seen as well. Elephantiasis of the left lower extremity is present, but keratosis of its skin is not so remarkable.

Laboratory Data (Table 2): The main laboratory data are as follows:

TABLE 2 Results of laboratory examination

1. Microfilaria negative	Albumin	48
2. FPT Intradermal reaction positive	BUN	20 mg/dl
3. VBS Intradermal reaction negative	Uric acid	7.0 mg/dl
4. Blood examination	Creatinine	0.7 mg/dl
Hb 13.4 g/dl	Na	132.7 mEq/l
RBC $389 \times 10^4$	K	4.7 mEq/l
WBC 8,250	Cl	105.0 mEq/l
5. Blood picture	Ca	4.15 mEq/l
Stab 3%	P	4.4 mg/dl
Seg I 6	Fe	120.0 mcg/dl
Seg II 18	Icterus index	4
Seg III 20	SGOT	18
Eosino 5	SGPT	9
Baso 1	TTT	2.9
Lymph 44	ZTT	11.0
Mono 3	Cholesterol	170 mg/dl
6. BSR	Ester ratio	78.7%
30 min. 10 mm	Lipoprotein	388 mg/dl
60 min. 27 mm	Neutral fat	125 mg/dl
120 min. 58 mm	Phospholipid	140 mg/dl
7. Urinalysis	NEFA	0.41 mg/dl
pH 6.0	Alkaline Phosphate	6.0 u
Protein (+)	Choline esterase	0.68
Sugar (-)	Amylase	170 u
Urobilinogen ( $\pm$ )	LAP	85 u
Keton body (-)	Au Antigen	(-)
Occult blood (+)	CRP	(+)
8. Blood biochemistry	RA	(-)
Serum protein 7.6 g/dl	ASLO	50 $\times$
A/G 0.92	LE cell	(-)
$\alpha$ 1 Globulin 4%	IgA	240 mg/dl
$\alpha$ 2 Globulin 9	IgM	90 mg/dl
$\beta$ Globulin 14	IgG	1,800 mg/dl
$\gamma$ Globulin 25		



Microfilariae in the peripheral blood negative. FPT reaction (filarial intradermal reaction) positive. VBS reaction (intradermal reaction for paragonimiasis) negative. Slight anemia is present and eosinophilia is not so clear. Erythrocyte sedimentation rate is 27 mm in one hour (Westergren), which is slightly accelerated. Hypergammaglobulinemia is present as well as slightly high level of serum Ig-G and slightly low level of cholin-esterase. Proteinuria and urinary occult blood are moderately positive.

#### DISCUSSION

Kagoshima prefecture is on the southernmost part of the Japanese mainland with a favorable mild climate and much rain. Tokunoshima is, in particular, a small island which has an area of about 250 square kilometers located to the south of Amami-honto (main Amami island) which is about 500 kilometers from the Kagoshima mainland. The annual mean temperature there is 21 C and it is over 20 C for eight months from April through November, which is thought to agree with the growth of filarial larvae and mosquitoes.

The result of filarial investigations made in Tokunoshima from prewar period until 1960 is shown in Table 3 which reveals 153 microfilaria positive persons were

TABLE 3 Results of filarial investigations in Tokunoshima

Tokunoshima Island	Localities	No. of persons	Mf. positive rate		Reported by	year	
		examined	Mf. positives	(%)			
Tokunoshima Island	Tokunoshima	118	47	39.8	Yoshinaga <i>et al.</i>	1913	
		216	16	7.4	Sameshima <i>et al.</i>	1954	
		251	37	14.7	Sato <i>et al.</i>	1955	
		392	43	11.0	Fukushima <i>et al.</i>	1960	
	Isen	27	4	14.8	Sato <i>et al.</i>	1956	
		41	6	14.6	Sato <i>et al.</i>	1956	
			1,045	153	14.6 (%)		

found among 1,045 examined (microfilaria positive rate 14.6%). For eight years from 1962 an anti-filaria policy sponsored jointly by central government and Kagoshima prefecture was taken and great results were realized consequently. The result of a government-sponsored anti-filaria work performed in 1962 by Kagoshima prefecture shows 8,968 microfilaria positive persons were detected out of 135,557 examined (microfilaria positive rate 6.6%). As far as the inhabitants of Tokunoshima were concerned 1,254 microfilaria carriers were detected among 10,642 persons examined as shown in Table 4, which reveals considerably higher microfilaria positive rate of 11.8%. All microfilariae were *Wuchereria bancrofti* species. As described above, Tokunoshima has been heavily infested with filarial worms since prewar period and all the worms detected there belonged to Bancroftian species. In connection with

TABLE 4 Results of filarial investigations (Kagoshima prefecture, 1962)

Localities	No. of persons examined	Mf. positives	Mf. positive rate (%)
Tokunoshima	4,454	662	14.9
Amagi	3,133	246	7.9
Isen	3,055	346	11.3
	10,642	1,254	11.8 (%)

the filarial symptomatic patients in Tokunoshima Sameshima *et al.* (1954) reported that they had found eighty patients including twelve hydrocele and twelve elephantiasis ones respectively. However, thanks possibly to filarial mass treatment carried out since 1962 microfilaria positive rate has decreased lately and in 1969 it decreased as low as 0.8% (40 microfilaria positives out of 4,610 examined) in Tokunoshima. With the decrease of microfilaria positive rate number of filarial symptomatic patients has also fallen off remarkably.

According to reports in the past, Blanchard (1900) reported a case of 224 pound scrotal elephantiasis and Pelletier (1912) a 100 kg one. The largest scrotal elephantiasis case ever reported in Japan is one found by Akaboshi, which weighed 63 kg and was 185 cm in transverse and 183 cm in longitudinal circumference. The case of elephantiasis presented in this paper is rather smaller in size when compared with those 'giant' scrotal elephantiasis cases reported in the past. However, in addition to scrotal elephantiasis, the case is accompanied by penile elephantiasis, which is thought to be very rare. The patient has been of mental weakness that it was very difficult to take medical history directly from him and we were obliged to depend on his families and neighbors for the most medical informations on the patient.

A case of huge penile and scrotal elephantiasis accompanied by that of the left lower extremity is presented in this paper.

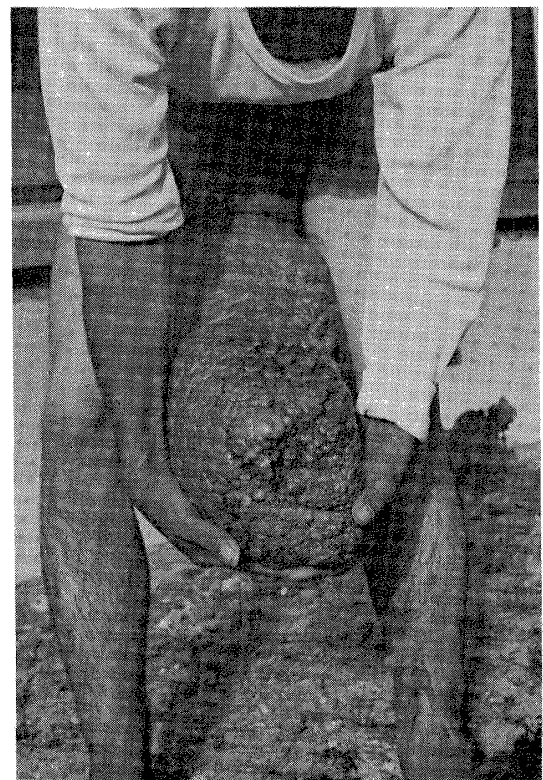
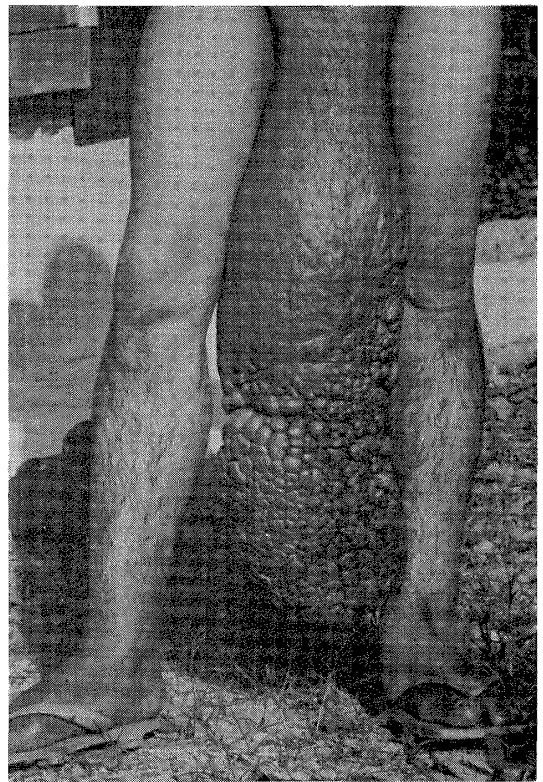
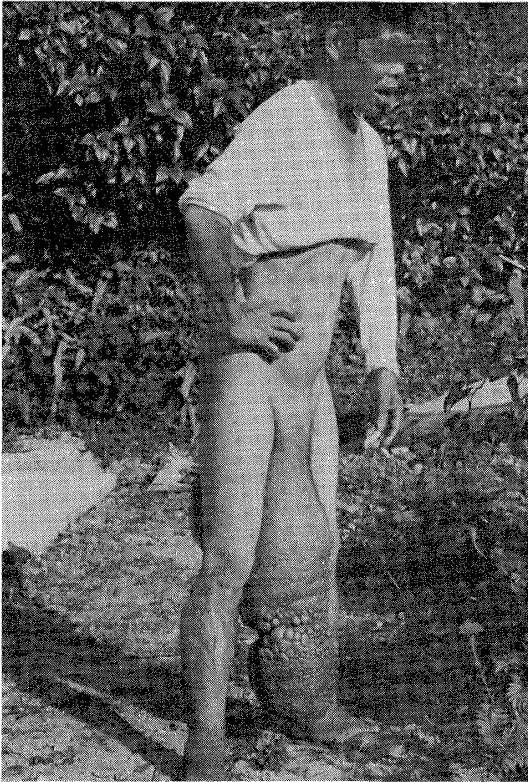
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## 巨大な陰茎、陰嚢象皮病の1例

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フィラリア症は、フィラリア性熱発作、リンパ管炎、乳び尿、陰嚢水腫、象皮病等の多彩な症状を呈する疾患である。鹿児島県はバンクロフト糸状虫症の濃厚な流行地であり、特に奄美大島地区は高度な浸淫がみられ、1962年のフィラリア検診の結果でも Mf 陽性率は11.8%で、かつては多くの典型的な象皮病患者がかなりみられた。然しながら最近では典型的な象皮病をみる機会は減少しつつあり、著者が行った鹿児島坊津町清原地区における、1954年から1965年にいたる11年間のフィラリア有症者の追跡調査の結果をみると、陰嚢水腫3例、乳び尿7例の新発生をみているが、象皮病の新発生は1例もなかった。すなわち乳び尿等は新発生があるが象皮病患者は半減していた。最近我々は、巨大な陰茎、陰嚢象皮病患者を経験したので報告する。症例は鹿児島県大島郡徳之島在住の44才の男性である。生来の白痴で IQ は測定不能であった。生後13才迄は蚊の多い山間の家に住んでいた。14才の頃から月に1～2回熱発作があり、30才迄続いた。17才頃から陰茎が異常に大きくなりだして34才の時には膝位の長さになった。34才の時保健所の検診でマイクロフィラリア陽性といわれ治療を受けた事がある。当科初診時、陰茎長は恥骨上縁から58 cm、陰嚢周は76.8 cm、冠状溝周43.5 cm、亀頭周50.5 cmであった。陰嚢、陰茎を合わせた重量は18.5 kg (患者体重52.6 kg) もあった。外尿道口は判然としなかったが、亀頭先端に不規則にみられる溝から尿がしみだしていた。各種の検査を行ったが EPT 皮内反応が陽性であり%赤沈値中等度促進、軽度の貧血、尿蛋白(+), CRP (+) の他には特に異常所見はみられなかった。



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